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1986

PROCEEDINGS

OF THE

Bristol Naturalists' Society

EDITED BY A.E. FREY
ASSISTED BY A COMMITTEE

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"Rerum cognoscere causas"—Virgil

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NOT LATER THAN 28th FEBRUARY, 1988.

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Miss A. HECKELS, B.Sc.,
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PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY

VOLUME 46

1986

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GENERAL & SECTIONAL PROCEEDINGS

COUNCIL, 1986

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REPORT OF COUNCIL, 1986

Membership at the end of the year was 561. At the Annual General Meeting the Officers and Members of Council were elected with Mr R.M. Payne as President.

The Annual Buffet Supper was held in May when Mr A.L. Grenfell spoke on "A Botanist in Greece".

The Hector Hockey Fund has made grants in support of the following: the publication of a guide to the Stoke Bishop Nature Trail; a paper in these *Proceedings* and a study of the insect fauna of salt marshes in the Severn estuary by students from the Department of Zoology, University of Bristol.

The Publicity and Fund-raising subcommittee organised a book sale and it is hoped that proceeds will be of the order of £400. Mr Grenfell has devised an exhibit for publicity displays in public libraries.

Mrs Kenney has once again organised the August week of BNS walks for the County of Avon 'Walking in Avon' programme.

Mrs A. Hollowell, in consultation with Miss I.F. Gravestock, has revised the text of the Frome Valley Nature Trail leaflet.

Council wishes to record its appreciation of the work undertaken for the last seven years by Miss R.C. Lee in her role as Hon. Circulation Secretary.

We record with regret the deaths of the following members during 1986: Mr K.T.F.M. Batty, Professor H.G.H. Kearns, Dr L. Harrison Matthews, Mrs M.R.M. Mullinger and Mr M.J. Penistan.

ACCOUNT OF GENERAL MEETINGS, 1986

January:	Symposium of short talks and slides on the natural history of lakes with emphasis on local habitats.
February:	"Studies of Urban Foxes and Badgers", by Dr S. Harris.
March:	"Heathland Ecology", by Dr N. Webb.
October:	"The Ecology of the Severn Estuary", by Dr C. Little.
November:	"Farming and Wildlife", by Mr Wilder.
December:	'The Natural History of Christmas" - members' evening.

Miss A. HECKELS, Hon. Secretary

GENERAL FIELD MEETINGS, 1986

22 Feb Mr D.A.C. Cullen. Chew Valley Lake. In the middle of the second coldest February this century, seven members attended and, despite ice on the lake, saw a number of birds with more in the surrounding countryside.

28 Mar Mrs V.J. Kenney. Shearwater & Longleat. A very early Good Friday but mostly dry, allowing a walk by the lake, through woodland and Longleat Park. A few signs of spring including early spring flowers but few birds in the mainly coniferous woodland.

19 Apr Mr D.A.C. Cullen. Abbotsbury and Portland. Successful south coast visit with good views of a Flamingo and various duck and waders on the Fleet; terns over the sea. Swallows and House Martins seen at Radipole and Cetti's Warbler heard. Good sightings of Guillemot and Gannet off Portland in poor weather but no migrants on land.

22 May Mr D.A.C. Cullen & Miss R.C. Lee. Evening visit to Silkwood on a cool but dry evening. Early spring flowers at their best and trees coming

into leaf in a late spring. Good bird song.

31 May Dr N. Malcolm. Brean Down. Interesting and rewarding afternoon in which members saw geological and historical features of the Down and much of the interesting flora, including the Somerset Hair-grass and the White Rockrose which was still in bloom.

14 Jun Mrs A. Hollowell. Felton Common to Butcombe and Redhill. A look at the wayside flowers and shrubs and changes in agricultural landscape from the larger straight-sided fields of the 1810 parliamentary enclosures, abutting Felton Common, to the irregularly shaped fields of medieval times near Butcombe. Some of the route was along old green ways, lying along parish boundaries, used by 18th century packhorse trains.

9 Jul Mrs V.J. Kenney. Wotton-under-Edge to North Nibley. Delightful evening walk through broad-leaved woodland. Nettle-leaved Bellflower, several St. John's Worts and woodland grasses. Fine views of the River Severn from the Nibley Monument.

19 Jul Miss R.C. Lee. Morning visit to woodland park at Brokerswood, Wilts. with good woodland flora, butterflies and broad-leaved trees including Wild Service. Afternoon visit to Rode Tropical Bird Garden.

16 Aug Mr R. Curber. Keyhaven and Pennington Marshes. A rewarding walk along the sea wall in good weather. Good views of waders including Grey Plover on the rocky shore; also Sandwich Terns in flight, Wheatears on passage and excellent view of a Montague's Harrier over the marshes. Good marsh flora.

20 Sep Miss M. Jervis. Severn Horseshoe Bend. An enjoyable day in perfect weather (after the poor summer). Excellent view of a small Severn bore at Arlingham. Many riparian plants and interesting estuary birds seen, fossils found and good view of Peregrine Falcon.

11 Oct Mr D.A.C. Cullen. Durleigh Reservoir and Steart. Well attended meeting on sunny autumn day enabling members to see the many duck, geese and waders on the reservoir in the best conditions. The high neap tide at Steart meant that few birds were seen although several moths were noted.

15 Nov Miss M. Jervis and Mrs V.J. Kenney. Sapperton. Interesting end of autumn walk in glorious weather along the derelict Thames-Severn canal and visiting both entrances of the 2½ mile long Sapperton Tunnel. A few woodland birds and ripe berries were seen; also brief view of a fox and adder.

RACHEL C. LEE, Hon. Secretary, Field Committee

REPORT OF THE BOTANICAL SECTION. 1986

At the Annual General Meeting, held in the Schools Room of the City Museum on 27 January 1986, the following were elected: Hon. Secretary & Treasurer: Mr A.C. Titchen; Committee: Mr R.M. Payne, Dr C.M. Lovatt, Mr M.A.R. Kitchen, Mrs C. Kitchen, Miss I.F. Gravestock, Mrs N. Vaughan-Davies, Mrs M.A. Silcocks, Mr A.L. Grenfell and Mr P.J.M. Nethercott.

The office of President became vacant following the resignation of Lady Rosemary FitzGerald who left Bristol to take up an appointment with the Nature Conservancy Council in Kent. The Committee recorded their thanks to Rosemary for her work in the Section and wished her well in her new position.

STATEMENT OF ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1986

Income and Expenditure for the year ended 31 December 1986

1985	Income	1986
2626	Members' subscriptions	3256
-	Income tax repayments (2 years)	542
137	Donations	99
449	Sales of proceedings and grants	224
59	Sale of books	370
6	General field meetings (profit)	-
13	Buffet supper profit	27
253	Bank interest	160
3543		4678
	Expenditure	
1143	Printing, stationery and publicity	805
387	Postages and telephone	462
1329	Proceedings (905) and Bird Report (440)	1345
78	Library, books	63
163	subscriptions and purchases of journals	205
25	fire insurance	25
7	Donations	8
269	Indoor meetings	228
-	General field meetings (loss)	10
220	Grants to Sections	75
£3621		£3226
78	Loss for year	
	Surplus for year	1452

Balance Sheet at 31 December 1986

1985			1986
4000	Government stocks at purchase price		4000
410	National Savings Bank		466
709	Cash at Banks - current accounts		739
1416	- deposit account		2925
16	Treasurer		-
10	Prepayment		10
80	Debtor		-
6641			8140
1536	Less creditors (hire of rooms 120, Proceedings (1985) 905, subscriptions in advance 268)		1293
5105			6847
	Represented by		
206	Harry Savory Illustrations Fund		206
84	Conservation Appeal		93
4185	Hector Hockey Memorial Fund		4466
630	General Fund at 31 December 1985	630	
	Add surplus on year	1452	2082
£5105			£6847

NOTES: (1) No value is placed upon the contents of the contents of the library and stocks of publications

(2) These accounts do not record balances held by sectional treasurers or the Ornithological Section Special Fund

Special Funds

Receipts and Payments for the year ended 31 December 1986

1985		1986
	Harry Savory Illustrations Fund	
206	Fund at 31 December 1985 and 31 December 1986	206
	Conservation Appeal	
84	Fund at 31 December 1985	84
-	Additions to Appeal in 1986	9
84	Fund at 31 December 1986	93
	Hector Hockey Memorial Fund	
4000	Fund at 31 December 1985	4185
340	Additions to Fund in 1986 (interest)	481
4340		4666
155	Grant from Fund (Severn Estuary Insect Fauna study)	200
£4185	Fund at 31 December 1986	£4466

P.J.M. NETHERCOTT

PJM. Nethercott

Hon. Treasurer
12 April 1987

Audited and found correct
T.B. SILCOCKS

TB Silcocks

Hon. Auditor
24 April 1987

GENERAL & SECTIONAL PROCEEDINGS

The following winter meetings were held:-

27 Jan	Annual General Meeting & Members' Evening.
24 Feb	"Charophytes", by Jenny Moore (British Museum).
24 Mar	Avon Flora Project - progress report.
27 Oct	"Discovering European Alpines", by Rev W. Tuckey.
24 Nov	"The Cotswold Water Park", by Mr D.E. Green.
8 Dec	Members' Evening - symposium on woodlands.

The following field excursions took place, under the leadership of those shown:-

26 Apr	Berrow Dunes, Mr R.S. Cropper.
18 May	Wakehurst Place, Sussex, Mr A.C. Titchen.
28 Jun	Tickenham area, Mr P.J.M. Nethercott.
19 Jul	Churchill and environs, Mrs Liz McDonnell.
16 Aug	Ferns of Mendip, Mr R.M. Payne.
31 Aug	Merthyr Mawr, Mr & Mrs M.A.R. Kitchen.
20/21 Sep	Sharpness Docks, Bristol & Avonmouth (Joint meeting with the Wild Flower Society), Mr A.L. Grenfell.

In addition to the above, 'specialist' meetings were held as follows:

23 Mar	Bryophytes (Mosses & Liverworts), Leigh Woods, Mr P. Martin (species list lodged in the Society's Library).
26 Oct	Fungus Foray, Shepton Mallet, Mr J.G. Keylock (species list lodged in the Society's Library).

A.C. TITCHEN, Hon. Secretary

REPORT OF THE ENTOMOLOGICAL SECTION, 1986

With six indoor and six field meetings, plus another six survey meetings, an interesting and varied programme was provided.

Winter indoor meetings held at the City Museum were as follows:

9 Jan	Annual General Meeting.
13 Feb	Members' Short Papers and Recorders Reports.
13 Mar	Symposium on Insect Photography.
16 Oct	Open Forum.
20 Nov	"Midge Research - Is it taking off?", by Dr P. Wilson.
18 Dec	Members' Evening and Annual Exhibition.

Field meetings held in the summer were:

20 Apr	Cleaves Wood, Mr A.H. Weeks.
14 Jun	Crook Peak, Mr R.M. Payne.
27 Jul	King's Weston Down, Mr G. Best.
23 Aug	River Avon, Saltford, Mr B. Harper.
14 Sep	Frome Valley, Stapleton, Mr S. Randolph.

MIDDLE HOPE SURVEY

The six meetings at Middle Hope brought the survey of this area to an end. The records will now be collated and a report issued.

Although attendances, especially at field meetings, were poor, the enthusiasm of individuals continued unabated and their specialist interests added considerably to the records of distribution of insects in the area. Of particular value is the Damselfly and Dragonfly recording by S. Randolph, the results of which will be published when complete. The acquisition of Mercury Vapour Moth Traps by more members will add considerably to our knowledge of the distribution of moths and the many other insects also attracted.

R.W. ROWE, Hon. Secretary

REPORT OF THE GEOLOGICAL SECTION, 1986

The following officers were elected at the Annual General Meeting held on 18 February 1986: President: Dr D.E.G. Briggs; Vice-Presidents: Dr D. Hamilton and Mr M. Curtis; Hon. Secretary: Dr P.R. Crowther; Hon. Treasurer and Hon. Field Secretary; Mr D.A. Wilson; Committee: Mrs G. Hamilton, Mrs M.E. Poolman, Mr V. Dennison and Mr D. Cope.

The following winter indoor meetings were held:

15 Jan Member's Evening - Rhaetic Vertebrate fossils from Chipping Sodbury displayed by Mr M. Curtis.

19 Feb "Geology in Philately", by Dr R. Bradshaw.

19 Mar "Geomorphology seen during 1985 Norway Meeting", by Mr V. Dennison.
"Geology seen during 1985 Norway Meeting", by Mr D.A. Wilson.

22 Oct "Geological Conservation and Teaching", Mr M.J. Harley (NCC).

19 Nov "People in a Landscape: A Portrait of the Gordano Valley", by Mr C. Copp.

10 Dec Members' Evening.

The following field meetings were held:

18 May Lower Carboniferous of the N.E. South Wales Coal Field, Dr V.P. Wright.

20 Jul Hock Cliff, Fretherne, Mr D.A. Wilson.

21 Sep Geology of the Shepton Mallet area, Professor D.T. Donovan.

D.A. WILSON, Hon. Field Secretary

REPORT OF THE ORNITHOLOGICAL SECTION, 1986

At the 62nd Annual General Meeting held on 24 January, Dr H.E. Rose was re-elected President, Mr S.M. Taylor Hon. Secretary and Mr T.G. Evans Hon. Treasurer. Mr F.G. Quinney retired from the Committee; Mr R.L. Bland and Mr G. Walker were elected to it.

Dr Rose's Presidential Address, 'A Celebration of Waders', was a superbly illustrated world-wide review of the *Charadriidae*. The other indoor meetings heard lectures by Dr S. Tyler on Dippers and Grey Wagtails and by Dr D. Worrall on the Flat Holm Project. The November lecture on 'Birds and the Changing Farm' had to be postponed at the last minute through the lecturer's illness. Mr S.M. Taylor showed the late J.H. Savory's slides on 'Birds and others in Pre-war Holland' in December.

All-day visits were paid to Steart, Dawlish Warren, Portland, the Cotswold Water Park, the Black Mountains and Kenfig; twelve half-day or evening walks were also held.

A meeting was held jointly with the Bristol Ornithological Club to report on fieldwork in 1985 and plan work for 1986, of which the major topic was the completion of the tetrad-based survey of Avon's breeding birds, organised by R.L. Bland, who was also continuing his Winter Garden Bird Survey.

S.M. TAYLOR, Hon. Secretary

REPORT OF THE LIBRARIAN, 1986

Members of the Library Committee continued to staff the Library twice a week in opening hours and took part in numerous working parties. Miss Peggy Keeton, formerly Librarian of Long Ashton Research Station, was appointed Librarian of the Society in January 1986 and, during the winter, recatalogued the British periodicals on cards, showing current shelf numbers. A typed alphabetical catalogue of British periodals in the Library was produced and made available to members at a small charge.

Following a decision to dispose of some rarely-used, mainly foreign periodicals and work by the Library Committee to compile lists of the often incomplete runs, the Librarian has produced a final, amalgamated alphabetical list which has been approved by the Committee. The periodicals will be offered to libraries and to booksellers specialising in secondhand journals.

During the year, 176 visits were made by 36 members who, between them, borrowed 169 items. Four books have ben purchased. Currently, 13 journals (including Reports and other serials) are received on subscription and 70 by exchange. We have been given 14 books and 14 volumes of journals, for which we are indebted to: Miss J. Bowen-Davies, Mr S.M. Taylor, Mr P.J.M. Nethercott, Mr P.S.H. Boyce and Mr D.A. Wilson.

We would like to express the Society's gratitude to Mr M. Heighton, Director of Arts, Bristol City Council and to Mr N. Thomas, Director, City Museum, Bristol, for the use of the Library room during the year. We are also indebted to the University Librarian for continuing to afford us some storage space for journals.

Miss I.P. Keeton, Hon. Librarian

OBITUARY: KENNETH THOMAS FRANCIS MUNSLOW BATTY (1908-1986)

Ken Batty C.Eng., M.I.E.E., M.I.Mech.E., was born on April 4th 1908 in Wolverhampton and attended Wolverhampton Grammar School. He qualified as a Civil Engineer, joining the Central Electricity Generating Board early in the 1930's in Worcester. When war came he served with distinction as Lieut. Colonel in the Royal Engineers.

He was Education Officer and later Safety Officer for the South-West Region of the C.E.G.B. and travelled over all parts of the region, retiring from the Board in 1971.

Ken contracted a serious illness in the war and was dogged by ill-health for the rest of his life. He married in 1955 Mary Elizabeth Norris and owed a great deal to her help and support, though she also was a victim of recurrent ill-health. Ken died in St. Mary's Hospital, Bristol, after an operation, on March 17th 1986.

He and Mary joined Bristol Naturalists' Society in 1955.

Ken played a large part in the founding of the Somerset Trust for Nature Conservation in 1964, which led, a little later, to the formation of the BNS Conservation Committee. He joined this Committee at its second meeting and was also a member of the North Area Committee of the Somerset Trust. He became a member of BNS Council in 1966, was a Vice-President for 1969 and 1970 and remained on Council until 1980. In 1970 he took over the Chairmanship of the Conservation Committee and it was in this capacity that the volume of work undertaken by Ken was so great and unremitting. He attended to every important matter himself, and, especially after his retirement, spent literally hours in interviews and correspondence with officers of County Planning Departments. Knowledgeable in several natural history disciplines (forestry, ornithology, geology and ecology) he could deal with most conservation problems without delay. His habit of combing the local press for news of forthcoming developments, his attendance public meetings, lobbying of councillors and wide acquaintance with people who mattered combined to make him a formidable and tireless opponent of plans that could harm the countryside. His flair for forseeing what results would inescapably follow from actions was invaluable.

His initiatives were responsible for the conservation of many of the sites now established either as nature reserves or SSSIs, or recognised as important by the Avon Wildlife Trust. Littleton Brick Pits, Stockwood Open Space, Lawrence Weston Marshes, Middle Hope, Cook's Folly Wood and the Avon Gorge properties, the Avon and Trym valleys, Cheddar Gorge and the Gordano Valley were all areas he surveyed in conjunction with Committee members and about which he made recommendations to planning officers. He was invited to attend conservation meetings of the Kenneth Allsopp Trust for Steep Holm; he studied and made recommendations on the Avon Structure Plan Project Report and the Mendip Hills A.O.N.B. Plan. His report on the Trym Valleys resulted in a grant of £60,000 from Bristol City Council for woodland management. He also initiated the Ashton Park Nature Trail and wrote the guide, and was responsible for overseeing the production of that of the Frome Valley. Both trails, undertaken for Bristol Corporation, proved very popular.

He was foremost in founding the Joint Committee for Nature Conservation in Avon (consequent on the local government reorganisation) in 1974, serving first as temporary Chairman and then as BNS representative from 1974 to 1978. This Committee was the forerunner of the Avon Wildlife Trust.

Towards the end of 1978, it was clear that his health would not permit him to continue as Chairman of the Conservation Committee and he was forced to resign. No successor could be found, so this proved to be the demise of the Committee.

In 1979 he was made an Honorary Member of the BNS.

Ken was elected to represent Walton Ward on Clevedon Town Council in 1976 and was the Council's Chairman from 1981 to 1982. Here he was active in attempting to preserve the natural amenities of the town and in saving non-built-up areas for wildlife. Another of his achievements was the drawing-up of a modified plan for a Green Belt in the Gordano Valley. The work he did remains on record as defining the most valuable areas and has been very useful to the Avon Wildlife Trust.

Kenneth Batty never lost touch with ordinary people. This, and the fact that he was so patently no crank or fanatic accounted in large part for his success as a conservationist. A most likeable man, unpretentious and easy to get on with, but a man with a habit of command, he spoke with authority and his views carried conviction. He probably corrected more erroneous opinions and put more local authority officers right on conservation than anyone, while remaining on good terms with his contacts. Not everyone agreed with all of his views, but he was seldom proved wrong. By personally attending to conservation problems and seeing the relevant people himself he became known as the key figure in Bristol conservation in the 1970's. To him not only Bristol, but the Avon Wildlife Trust owes an enormous debt. He could truly be said to have worn himself out in the service of conservation.

I.F. GRAVESTOCK

Proceedings of the Bristol Naturalists' Society (1986), **46**: 11–18

BRISTOL'S WATER SUPPLY - HISTORY AND ENVIRONMENTAL ASPECTS

by S.M. TAYLOR

(20 Station Road, Nailsea, Bristol BS19 2PD)

INTRODUCTION

This account summarises the history of Bristol's water supply and goes on to outline the modern system and some of its consequences of interest to naturalists and conservationists.

THE PAST

Surrounded by hills composed of alternately porous and impervious strata, and with plentiful rainfall, ancient Bristol had an ample supply of spring water. Parker (1934) listed fifteen springs or groups of springs in and around the walled city, some with a very long history: Hazel Well on Kingsdown, for example, figured in Saxon records of 883. Water was led by conduits to stone cisterns, typically one in each parish. Some supplies were acts of charity - in 1207 Robert Berkeley gave Redcliffe parish a supply via lead pipes from Ruge Well at Knowle - but many conduits were constructed by religious houses and later taken over by the city, which then paid for upkeep. One, provided by the Dominicans of Quaker's Friars, was later extended to the Quay on the River Frome and became the city's principal conduit, for centuries supplying shipping. "Le condit appelle kaie pipe ...assis sur la Kaie de Bristuyt" figures in a covenant of 1 October 1376 under which Hugh White, plumber, undertook to maintain the city's water system for an annual fee of £10 (Veale, 1933). The Quay Pipe was supplied from the Panni Well (later known as the Boiling Spring) in Ashley Vale, near the eventual site of Ashley Hill Station. The pipe was fed from an open stone cistern, with results often mentioned in the city accounts, as in December 1574: "Paid for taking three cats out of the Key Pipe ...five days, 5s.6d." The costly nuisance recurred until the spring was enclosed in 1679 at a cost of £154 (Latimer, 1900, 1908). Puritan magistrates preferred godliness to cleanliness and in 1654 closed all conduits on Sundays.

The conduits were augmented by numerous private shallow wells. In time many of these became contaminated from cess-pools and burial grounds, causing recurrent epidemics. To improve the situation, the first Bristol Waterworks Company was formed in 1696; water from the Avon at Hanham Mills, well upstream of city pollution, was pumped to a small reservoir at Lawrence Hill, whence it flowed under gravity to households paying £2 a year. The scheme did not prosper and it was abandoned in 1782, contemporary opinion holding that the abundant spring water made other supplies unnecessary (Parker, 1934).

This view changed over the next sixty years for reasons, listed by Parker, that can be summarised as the growth of new suburbs without conduits; fouling of most of the shallow wells and contamination of some conduits; pockets of very high mortality; a large population, rapidly increasing as a result of the Industrial Revolution; endemic fevers that seemed to be linked to water, with cholera outbreaks in 1831 and 1849; and growing attention to sanitary science with its aim of a pure water supply to every house. In 1843 the Commission on the Health of Towns was told that the supply was one of the worst in the country: 5,000 people, mostly in Clifton, had piped water from private springs, while 73,000 had to rely on the conduits and public or private wells, and "the filthy habits of the poorer classes ...are mainly attributable to the deficient supply of water" (McGrath, 1975).

Various plans of action met with problems but one, by the Merchant Venturers' Society, to supply Clifton from the Black Rock Spring ("the new hot well") in the Avon Gorge had, by 1845, reached the stage of a reservoir near the Observatory and a pumping station in the gorge to supply it. The same year a group of citizens formed a new Waterworks Company with £200,000 capital, to supply the whole city from springs in the country to the south. After strong opposition from the Merchants its enabling Act was signed in July 1846. Under this it absorbed the private schemes and the story of Bristol's modern water system began with massive engineering activity. The first supply, from the Cold Bath Spring at Barrow Gurney, reached the city on October 1, 1847. Service reservoirs were built at Bedminster, Clifton and Durdham Down, and a holding reservoir at Barrow Gurney to supply them. This received most of its water by gravity from springs at Litton and Chewton Mendip (sources of the River Chew) and in Harptree Combe, via 18 km of pipes, aqueducts and tunnels constituting the so-called "Line of Works", a major constructional feat completed in 1850 and still functioning. Compensation reservoirs at Litton (1846) and Chew Magna (1847) provided a minimum flow in the depleted Chew; (many of these features are illustrated in Figure 1).

By February 1850 only 3,152 houses were connected, but growth soon accelerated, helped by the adoption of water-borne sewage. In the great drought of 1864 the Mendip springs almost dried but 200,000 gallons or nearly one megalitre per day (Ml/d) still flowed from the Boiling Spring and this was utilised to maintain a small supply (Latimer, 1880). As demand rose, more springs were tapped and deep wells were dug at Chelvey. One of these, of 2 m bore and 50 m depth, dug with great difficulty in 1871-2, had a yield of nearly 7 Ml/d (Pearson, 1891). The Barrow Gurney storage was twice enlarged and a treatment works built, to be followed at the turn of the century by the damming of the River Yeo to form Blagdon Lake (BL). By 1934 some 400,000 people, mainly in Bristol, had a steady supply of 60 Ml/d. This was not the city's total water usage; industry had long employed private deep boreholes and Parker listed several in breweries, a chemical works, an ironworks, a laundry and others. Also, the supply from the Boiling Spring to the Quay Pipe, by then diverted to Bristol United Brewery in Lewin's Mead, was reported to be yielding 2 Ml/d. In addition river water was borrowed for cooling purposes.

In the mid 1930's Cheddar Reservoir was built at Axbridge to make full use of the Cheddar Gorge springs, the water being treated at Barrow. Damming of the Chew was authorised in 1939; work started in 1950 and the Queen opened Chew Valley Lake (CVL) on April 17th, 1956. Its water is treated partly at Barrow and partly at a new plant at Stowey. Another new plant at Cheddar is fed from the adjacent reservoir, most of its output now going to the south of the area rather than to Bristol. Finally, since 1965, water has been taken from the Severn.

This last development illustrates the complexity of modern systems. Water taken from the southern end of the Sharpness and Gloucester Canal at Purton passes to treatment plants at Littleton (since 1965) and Purton itself (since 1973). The canal is replenished from the Severn via Gloucester Docks, as well as by the flows of the Rivers Cam and Frome. To ensure a regular supply, the Bristol Company joined forces with twelve others dependent on the Severn to dam Afon Clywedog, a Severn tributary in the Powys mountains, so forming a deep reservoir 10 km long. This retains 50,000 Ml of winter rainfall which can be released into the Severn at Llanidloes, 250 km upstream from Purton, when the river is low.

As to the old sources, the United Brewery site has been cleared and rebuilt on, and the fate of the former Quay Pipe is obscure. The Boiling Spring itself was still yielding 2 to 3 Ml/d in 1897 (Pearson, 1897) and in the early 1960's it was considered, but not adopted, as a supplementary source for the public supply (Hewett, pers. com., 1987).

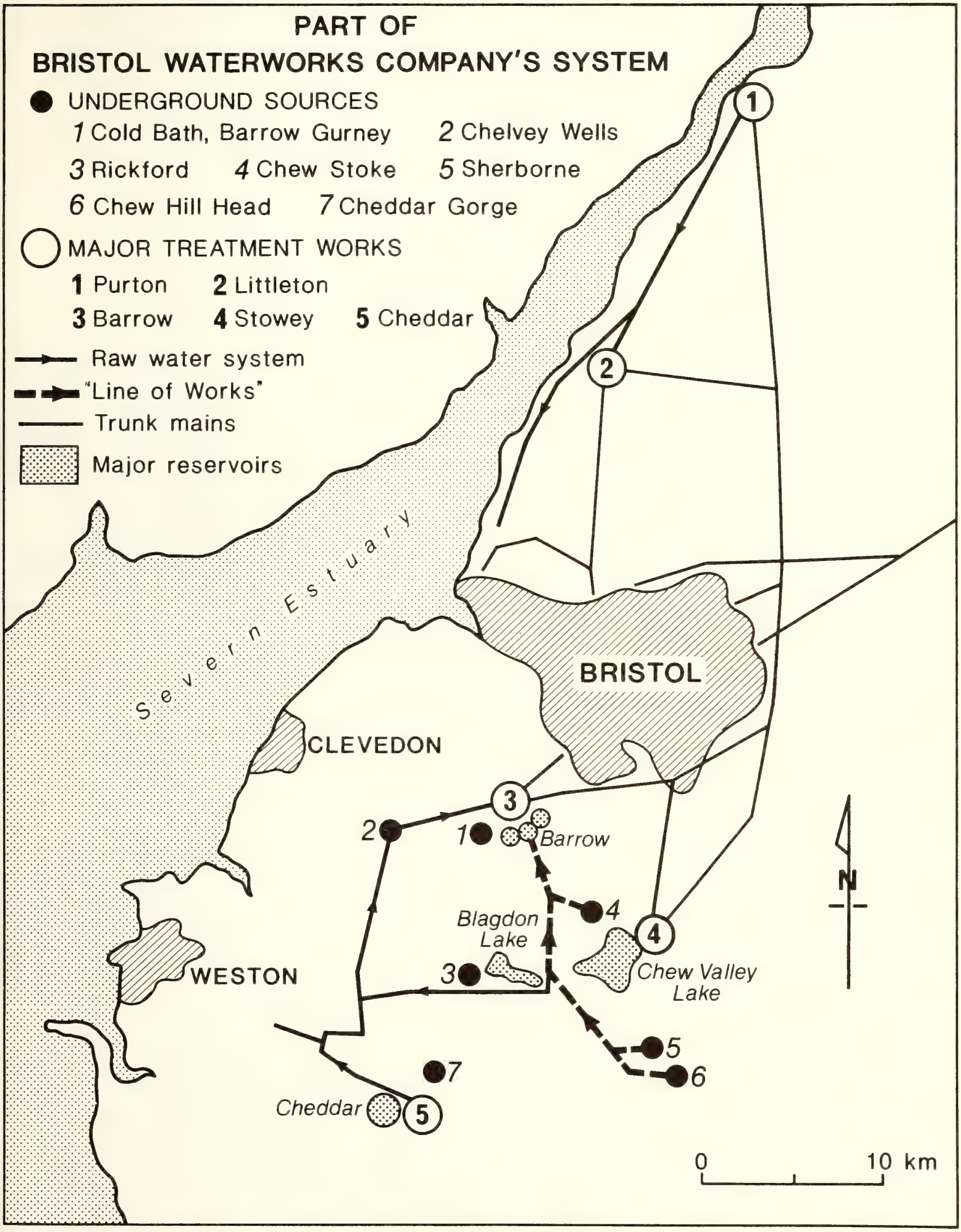
PART OF
BRISTOL WATERWORKS COMPANY'S SYSTEM
● UNDERGROUND SOURCES
1 Cold Bath, Barrow Gurney
2 Chelvey Wells
3 Rickford
4 Chew Stoke
5 Sherborne
6 Chew Hill Head
7 Cheddar Gorge
○ MAJOR TREATMENT WORKS
1 Purton
2 Littleton
3 Barrow
4 Stowey
5 Cheddar
Raw water system
"Line of Works"
Trunk mains
Major reservoirs
Severn Estuary
BRISTOL
CLEVEDON
WESTON
Barrow
Blagdon Lake
Chew Valley Lake
Cheddar
N
0
10 km

Figure 1. Sketch map of part of Bristol Waterworks Company's system showing main features related to Bristol's water supplies.

THE PRESENT

Bristol Waterworks Company was one of 28 private concerns to survive when the industry was reorganised and the Regional Water Authorities were set up in 1974. Responsibility for sewage disposal, flood protection and pollution prevention lies with Wessex Water, whereas the Company is contracted to provide the public water supply within its area. By March 1986 it was supplying the whole of Avon county (except Bath), as well as a third of Somerset and small parts of Gloucestershire and Wiltshire. Well over a million people used some 340 Ml/d from a variety of local schemes (more than twenty have been absorbed since 1945) as well as the major ones. Out of this total, Bristol and its suburbs used some 270 Ml/d.

On average about half of the Bristol supply comes from the Severn. Littleton sends settled raw water to ICI's Severnside site, and treated water to service reservoirs at Marlwood for the Thornbury area and Almondsbury for north Bristol and Filton. A large covered reservoir at Pucklechurch, supplying east Bristol, is fed from Purton works by 29 km of trunk main, which was extended to link with the Barrow and Stowey works in 1983. The rest of the Bristol supply comes from the south; service reservoirs at Keynsham and east and south-east Bristol are fed from CVL via the Stowey Treatment works, while service reservoirs for Bedminster, Ashton and the city are fed via the Barrow works from the Barrow storage reservoirs. These in turn are supplied from BL, CVL, the Line of Works and the Cold Bath Spring. In emergency the Barrow works can take water directly from Cheddar. When the Mendip flow diminishes in summer, usage of the softer but costlier Severn water is increased and the interface between the two supplies moves southward within the city; in winter this state of affairs is reversed, and it is said that sensitive palates within the frontier zone can detect the change (Heaton-Armstrong, pers. comm., 1987).

By the end of 1986 the use of subsidiary supplies had greatly decreased. Only two private boreholes together yielding 1 Ml/d were still licensed, and while there were also seven licenses to take a total of 49 Ml/d of river water, 44 Ml/d of this was to cool fermenters at Distillers' yeast factory in Avon Street, which was closed down at the end of March 1987.

ENVIRONMENTAL ASPECTS

An early result of the new water supplies was a great improvement in public health; over 1872-74 the average death rate from diarrhoea was 1.9 per thousand, against a national average of 2.55 (Davies, 1875). With the supply of ample water came the need to remove it, so that 160 miles of main sewers had been built by 1875, discharging into the tidal Avon (Davies, 1875). All principal streets were well and carefully watered with mains water daily during the six summer months to keep down dust, especially necessary since all transport was horse-powered. Public hygiene improved progressively, but pollution of the Avon persisted in varying degrees until the 1960's (Gray, 1988).

Otherwise the main impact of the new water supplies has been through the reservoirs, in creating wild-life habitats and more recently in terms of human leisure activities and awareness of the countryside, so that the remainder of this account concerns these topics. Bird life is a conspicuous aspect of the reservoirs - well over 200 species, from common residents to rare vagrants, have been found within their enclosures; full details are given in the annual Bird Reports for Somerset (re Cheddar) and Avon (for the others), lack of space allowing only certain important features to be mentioned here.

Table 1 lists the reservoirs, with their years of commencement and of filling, their capacities in megalitres and surface areas in hectares.

RESERVOIR	DATE STARTED	DATE FULL	CAPACITY (Megalitres)	AREA (Hectares)
Litton Upper and Lower	1846	1847	680	6.1
Chew Magna	1847	1848		2.2
Barrow Gurney No. 1	1848	1850	680	31
No. 2	1864	1866	910	
No. 3	1884	1886	2,400	
Yeo (Blagdon Lake)	1891	1903	7,700	183
Cheddar	1934	1937	6,000	97
Chew Valley Lake	1950	1956	20,460	500

Table 1. The reservoirs of Bristol Waterworks Company.

Litton and Chew Magna are too small to be of great significance for wild life. The Barrow group and Cheddar have concreted margins, so they lack water-fringe vegetation and breeding or shore-feeding birds. They are most important to birds in autumn and winter and Leach's 1935 notes on the Barrow group are still in general applicable. At Cheddar the considerable and essentially uniform depth (6 m) fits it mainly for coot (up to 5,000 in winter) and diving ducks, and for coarse fish rather than trout.

Blagdon (BL) and Chew Valley (CVL) Lakes are scenically attractive, both through their settings and the meadows and woodland within their enclosures (120,000 trees were planted during the making of CVL). Some of the meadows have never been ploughed and are now safeguarded examples of an increasingly rare habitat. In the plantations roe deer are seen occasionally and muntjac rarely, grey squirrels are common and sparrowhawks breed. Mink descend the rivers and defy attempts at control. Both lakes are dammed and flooded valleys and so have natural and gently shelving banks with extensive shallows so that they support a rich marginal and aquatic flora. Both have been designated sites of special scientific interest and in 1983 CVL was reclassified as a Grade 2 SSSI; it is also a specially protected site under EEC directives. Its large size makes it conspicuous and attractive to migrating and wintering birds. The rich insect life brings thousands of swifts and hirundines to feed over the water after their long spring journey and to fatten in autumn before departure; in between, breeding swifts travel from Bristol and elsewhere to feed there.

At both lakes the water is of low turbidity, allowing good light penetration. CVL in particular has a high inflow of nitrogen compounds derived from the fertilisers used to boost grass growth in its 58 sq km of catchment area, where cattle numbers tripled in the 1950's and 1960's (Brown, 1969), and this makes conditions ideal for plankton growth. The animals are mainly water fleas (*Daphnia*) and copepods (*Cyclops*) and the typical plant plankton are diatoms (usually *Asterionella*) in spring, assorted green algae in summer and blue-green algae, usually *Microcystis* and *Coelastrum*), in autumn. Normally algae attain only moderate densities and cause no problems but occasional upsets occur. In January 1968 CVL was out of use for twelve days when *Tribonema* bloomed and blocked the Stowey filters faster than they could be cleared. Very few *Daphnia* were then found, the significance of which became clear only later. In April there followed a huge bloom of another yellow alga, a *Monodus* not previously detected and so minute that individuals passed through the filters, with severe operational consequences as taste and turbidity problems made the water unusable for several weeks. Lengthy studies of these events (Bays, 1969) showed that the contents of a communal sheep dip, regularly discarded on to a particular field, must have accumulated for years in an underground cavity which collapsed in the winter of 1967, releasing an estimated 20 kg of Lindane and 14 kg of Dieldrin into a stream and thence into the lake. This killed the *Daphnia* or prevented their normally rapid spring reproduction with the result that the *Monodus* were not kept in check and their numbers exploded. (It was later shown, not only that *Daphnia* consume *Tribonema* but that a single individual could rapidly dispose of 30 million of the tiny *Monodus*). Besides *Daphnia*, Chironomid midge larvae and other invertebrates were also affected. In May a bloom of *Asterionella* reached one of the highest densities ever known and other algae bloomed later in the year. The whole episode emphasised the fragility of the lake's biological equilibrium and the far-reaching results that can attend on human activities.

Extensive beds of reeds (*Phragmites communis*) are an important feature, especially at CVL. In summer they provide cover for grass snakes, frogs and breeding waterfowl, along with nest sites and a rich supply of insect food for a colony of reed warblers (at least 200 pairs in 1985). Other songbirds feed in and over the reeds, especially at migration times, and roe deer from Mendip Forest lie up in them, while in most winters they shelter one or two bitterns and a few bearded tits, refugees from the chill of East Anglia. The gentle slope of the shores means, however, that a fall in water level can move the shore line partly or entirely away from the reeds, and this can inhibit breeding by waterfowl needing shelter and by insects like dragon-flies that require both vegetation and water. In 1983 when CVL was full, 68 broods of great crested grebes and 100 broods of coots were seen, whereas in 1984 with a low water level there were no grebe broods and only six of coot. Outside the breeding season exposed mud attracts migrating and wintering waders, but with high water levels few are to be seen. Mud exposed in summer quickly acquires a dense weed cover which gives rich pickings when flooded again - late in 1984 these conditions attracted teal, mallard, pochard and tufted duck totalling 9,000 to CVL and over 5,000 to BL. In view of the large effects that changes of water level can cause, it is worth noting that changes may be due to engineering work, perhaps elsewhere in the system, and not just to fluctuations in supply or demand.

Besides these fluctuations the breeding numbers of some waterfowl - shoveler and tufted duck in particular - at CVL have fallen sharply since the early 1960's, and some of the conservation measures referred to later are attempts to reverse this decline. Also redshank, grey partridge, yellow wagtail and whinchat, which used to breed in small numbers on the grassland have ceased to do so in the last ten to twenty years. The second and third species have declined generally in Britain, but it seems likely that both predation and disturbance have played a part here.

When waterfowl gather at the reservoirs in late summer to moult, the large size and nearly circular shape of CVL allows flightless birds to stay far away from shore, and up to 4,000 use it. Mallard are commonest with up to 2,000, but great crested grebes can number over 500, perhaps one in twelve of the British population. In winter fifteen species of ducks, geese and swans use the reservoirs, typical totals being 1,400 at Cheddar, 1,600 at Blagdon, 2,900 at CVL and 700 at Barrow Gurney, though many more occur at times (Owen *et al.*, 1986). At CVL a large roost of gulls also forms in winter and when last censused in 1979-80 this held 18,000 black-headed and 12,000 common gulls as well as 1,400 of other species.

In 1969 the southern arm of CVL, including Herriott's Pool, was designated as a nature reserve on the initiative of an *ad hoc* group of local naturalists who advised the Company on its management and on other conservation matters. The whole lake received SSSI status in 1972. From 1981 water authorities have been required by the Wildlife and Countryside Act to have regard to nature conservation and this has led to a great deal of active conservation work, directed by the Avon Wildlife Trust under formal arrangements with the Company. Priorities are set with the help of a committee of local naturalists (essentially the old *ad hoc* group) and the results have included construction of secluded sinuous waterways and islands in the reserve, arrangements to retain pools and to maintain a reed-water interface when levels fall, and restoration of overgrown meadow areas on Denny Island. Other work at the reservoirs has included woodland maintenance and much tree-planting.

From 1904 BL was stocked with trout and rapidly became famous among anglers. The Barrow group followed and, since 1958, CVL. Some 100,000 trout are now released annually, after a year spent at the Ubley hatchery (set up in 1904) and, in most cases, a second year in pens at Blagdon, Chew Stoke or Litton; Barrow is stocked with yearling fish. Over 20,000 visits by anglers from all walks of life are made annually and their returns show annual catches of over 45,000. The record fish so far is a rainbow trout of 7.4 kg (16lb 5oz) taken at BL in 1986. Coarse fishing has been developed at Cheddar Reservoir since 1974. As CVL filled, great efforts were made to exclude coarse fish, but a sizeable roach population built up, though it has declined since 1964 through netting and parasitism (Wilson, 1971).

Access for bird-watching has been allowed under permit for many years and sailing was started at Cheddar in 1947, the first time a primary water supply source was so used. The Government's 1966 circular on "Use of Reservoirs and Gathering Grounds for Recreation" led by stages to a great increase in recreational use. In 1967 sailing was extended to CVL and the first of several bird-watching hides was built. Canoeing and model yacht sailing take place at Chew Magna, wind surfing at Cheddar and CVL and sub-aqua activities at Barrow No. 3. A water sport complex is planned at Barrow No. 2. In all this, the dates, times and areas used have been chosen to minimise interference with bird life and so far the result has been an admirable example of how conservation and recreation can co-exist, a far cry from the winter wildfowl shoots which once aroused bitter opposition from naturalists. A desire not to disturb the financially significant angling and sailing interests may well have influenced the decision to exclude such pastimes as power boating, water skiing and catamaran sailing, to the benefit of wild life in general.

Facilities have also been provided for the general public. Car parks, viewing areas, picnic sites, waterside walks, a shop and toilet facilities at CVL are heavily used and there are plans for extensions there and also at BL. An information centre describing CVL and its wildlife was formally opened by the Minister of State for the Environment on April 10th 1987. All these public facilities have been constructed and maintained to a high standard and many visitors must have gained increased awareness as well as pleasure from them. Major contributions to the capital costs of the amenity works have been made by local authorities among others. The conservation activities and bird-watching hides have been largely funded by the World Wildlife Fund, Nature Conservancy Council, Countryside Commission, Royal Society for the Protection of Birds and, on a smaller scale, local naturalists' bodies, including this Society. The Waterworks Company itself has made substantial inputs to all the schemes. The sporting activities are self-financing, though some have received grant support from outside bodies such as the Sports Council.

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APPENDIX

The major sources of Bristol's water supply, and the dates when supplies became available, are as follows. Many other springs and boreholes are used to provide local supplies elsewhere within the Company's area.

1846	Cold Bath Spring, Barrow Gurney
1850	Spring in Watery Combe, Chewton Mendip
1850	Spring in Harptree Combe
1865 on	Deep wells at Chelvey*
1882	Sherborne Spring, Litton
1889	Langford Spring
1889	Rickford Spring
1901	River Yeo (Blagdon Lake)
1922	Springs in Cheddar Gorge**
1953	River Chew (Chew Valley Lake)
1965	Sharpness and Gloucester Canal

* Now used largely to supply the area from Nailsea to Portbury.

** Now used mainly to supply the southern part of the supply area.

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BRISTOL'S SEWAGE AND THE BIRDLIFE OF THE TIDAL RIVER AVON

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INTRODUCTION

This paper describes how the development of Bristol resulted in considerable pollution of the tidal River Avon. An account is given of the civil engineering works that were carried out to remove sewage from the river. The past and present quality of the Avon and its capacity to support birdlife are discussed.

THE BRISTOL AVON

The Bristol Avon rises in the Cotswold Hills and runs for approximately 130 kilometres to its confluence with the Severn Estuary at Avonmouth. In general terms it is a lowland river draining a catchment composed mainly of limestone or lime-bearing strata. Before reaching Bristol it passes through much productive agricultural land, several good sized towns and the City of Bath.

The upper tidal limit of the river is accepted to be Netham Weir, approximately 18 km from the mouth, though this is overtopped by some spring tides. The tidal range is very large, exceeding 13 metres at the mouth on high spring tides.

THE DEVELOPMENT OF POLLUTED CONDITIONS AND CORRECTIVE CIVIL ENGINEERING WORKS

From mediaeval times a number of stone culverts carried wastes from the relatively small population into the River Avon and its tributary, the Bristol Frome, for the tide to carry away, apparently without offence (Anon, 1970). Between 1803 and 1809 the "Floating Harbour" was created by enclosing part of the rivers Avon and Frome with lock gates and constructing the "New Cut" between Netham and Hotwells to divert the tidal Avon around the new docks. Because sewage continued to be discharged into the now semi-stagnant waters of the floating harbour, offensive conditions became inevitable. A culvert was constructed to divert the Frome into the New Cut and in 1851 a committee of the City Council was formed to act as a local Board of Health. This committee drew up plans for the provision of trunk sewers to collect sewage from each district and convey it to outfalls on the Avon. Over 40 miles (64.4 km) of sewer was constructed between 1855 and 1875.

The problem of the treatment and disposal of the sewage still, however, remained and between 1879 and 1905 several schemes were prepared. The proposals included schemes to discharge untreated sewage to the Severn Estuary and others to build treatment works at Sand Bay near Weston-Super-Mare or at Avonmouth. The Avonmouth proposal was approved by the City Council but was rejected by the ratepayers on the grounds that it might inhibit the development of the Avonmouth Docks. It was not until 1955 that the Bristol Regional Foul Water Drainage Scheme for the removal of sewage from the Avon was finally approved.

By the late 1950's over 100 million litres of crude sewage per day discharged to the Avon from over fifty outfalls. Pollution of the tidal Avon had become so severe that at times the river water became deoxygenated, with the resulting anaerobic conditions giving rise to offensive smells. To abate this problem, the river was effectively sterilised by pumping chlorine into it from several stations sited along its banks. In a dry summer over 300 tons were used.

The Regional Foul Water Scheme, by including seven neighbouring local authorities, extended the reach of the sewage system to include, for example, the suburban areas of Kingswood/Warmley, Yate/Chipping Sodbury and some villages as far north as Tormarton and Hawkesbury Upton. This brought benefits to both the non-tidal Avon and, in particular, to the Frome above Bristol. Five existing sewage treatment works were closed. The major civil engineering works necessary included 40 km of new sewer, ten pumping stations and four crossings of the Avon by means of inverted syphons. The largest and deepest inverted syphon is in the Avon Gorge, where it is necessary to go to a depth of 42.6 m to pass below the Pleistocene buried channel of the river.

Construction work began on the Regional Scheme in 1959 and the first stages of the Avonmouth Treatment Works were commissioned in 1966. The latter currently receives 186 million litres per day of sewage and trade effluent. This represents a domestic population of approximately 500,000 and industrial effluent of a strength equivalent to approximately 350,000 people. At the works the sewage first receives preliminary treatment to remove grit and rags. Solids are then removed from suspension in sedimentation tanks.

The works is consented to discharge the settled sewage to the Severn Estuary. Because of a local demand the works is provided with the capacity to treat up to 45.4 million litres per day of settled sewage to an industrial water standard using the activated sludge process. The "sludge" obtained from both primary and secondary sedimentation is subjected to anaerobic digestion which reduces the organic content and produces methane gas. This gas is used to generate electricity to power the works and the refuse incinerator nearby. Some power is even supplied to the National Grid. The treated sludge is pumped to a loading quay at Shirehampton, where it is taken aboard the water authority's ship M.V. *Glenavon* and disposed of at sea.

IMPROVEMENTS IN WATER QUALITY

Because of the scale and cost of the sewerage works involved, the diversion of discharges from the river to the treatment works has been by means of a phased programme extending over many years. This is reflected in Table 1, which is based on the national river quality surveys (Department of the Environment 1971, 1978, 1986 National Water Council, 1981). The scheme used in the 1970 and 1975 reports classified rivers and estuarial waters as 1 - unpolluted,

NWC/DOE CLASSIFICATION				
SITE	1970	1975	1980	1985
Avon immediately upstream of Netham Weir	4	4	3	2
Feeder Canal/Floating Harbour	4	4	2	2/1
Tidal Avon	4	4	C*	B
	* Netham to R. Trym			

Table 1. River quality at main sites in Bristol, 1970-1985.
(For classification categories, see text).

2 - doubtful, 3 - poor and 4 - grossly polluted. The system used in the 1980 and 1985 reports is basically similar and classifies river water as 1 - good, 2 - fair, 3 - poor and 4 - bad. Tidal waters are classed from A - D, ie. good, fair, poor and bad.

Although much of Bristol's sewage and industrial effluent was diverted to the treatment works during the 1960's and 1970's, the improvement in river quality was not reflected in the 1970 and 1975 surveys. However, improvement following the closure of a board mill just upstream of the tidal section in 1980 and the diversion of sewage and industrial effluents from the Brislington area during 1984 is apparent from the 1980 and 1985 surveys. The appearance of the Avon downstream of Brislington has certainly improved since 1984 and during the 1980's there has been a marked improvement in the penetration of the tidal Avon by estuarine and salmonid fish (Wessex Water Authority, unpublished).

BIRDLIFE

Members of Bristol Naturalists' Society Ornithological Section began counting birds on the tidal Avon partly in anticipation that the improved condition of the river might lead to changes in the bird population (Rose, 1979).

Counts have been made in the Sea Mills area since 1974 (Ogbourne, 1976; Rose, 1979, 1982, 1985) and between Netham and Hotwells since 1977 (Gray, unpublished). Birds using the Floating Harbour/Feeder Canal have been counted since 1978 (Gray, unpublished).

	SPECIES		
SITE	BLACK-HEADED GULL	MALLARD	REDSHANK
Netham to Hotwells (period 1978/79-1986/87)	552 (range 386-782)	176 (range 101-228)	10
Sea Mills* (period 1976/77-1983/84) * Based on data from Rose 1979/82/85.	1980 (range 1300-3000)	95 (range 49-135)	116 (range 71-155)

Table 2. Mean winter peak counts (from monthly counts Sept-Mar) of main species using the tidal Avon.

Table 2 gives the mean winter peak counts of three of the main species at the two sites on the tidal Avon. In addition, Herring Gulls, *Larus argentatus* and Lesser Black-backed Gulls, *L. fuscus* are also found on the river and have bred on roof-tops in central Bristol since 1972 (Rock, 1983). Other gull species occur only in small numbers. Lapwing, *Vanellus vanellus* and Curlew, *Numenius arquata* occur regularly in the Sea Mills area but other waders are seen only occasionally or in small numbers. Duck species other than Mallard are not usually seen in significant numbers, their appearance often being associated with periods of severe winter weather. A flock of Mute Swans, *Cygnus olor* winters on the Floating Harbour (mean winter peak 1978/79 to 1986/87 = 42) and some birds of this species are present in the harbour all year.

The treatment works at Avonmouth and the associated fish rearing ponds are an incidental benefit to birds, attracting in particular gulls, winter wildfowl and some of the less common passage waders (Gray, 1976).

DISCUSSION

From the account given here it can be seen that the postponement of schemes to remove sewage from the Avon resulted in gross pollution of the river until the Bristol Regional Foul Water Drainage Scheme began to come into operation during the 1960's.

There has been a progressive improvement in water quality with the introduction of the various phases of the scheme, although these improvements did not register in the terms of the NWC/DOE classification prior to the 1980 report.

Elimination of sewage discharges would be expected to have a direct effect on birds feeding at outfalls and an indirect effect on those feeding on invertebrates in the mud or on algae or other plants growing on the mud. By way of a comparison, Owen *et al.* (1986) cite two examples where the discharge of sewage to estuarine waters has affected wildfowl populations. On the Solent, discharges are thought to have resulted in an increase in the number of Brent Geese, *Branta bernicla* by encouraging the growth of the alga *Enteromorpha.* The number of wildfowl feeding in the outer Firth of Forth has declined dramatically since sewage was diverted to a treatment works in the 1970's.

The figures quoted in Table 2 reflect the typical numbers of the main species using the tidal Avon at the two counted sites. Although there is some annual fluctuation in numbers there is no obvious upward or downward trend.

Redshank, *Tringa totanus* are consistently less common on the Netham-Hotwells section of the river, perhaps due to factors associated with the narrowing of the estuary (eg. less exposed mud, intensified disturbance). The Mallard, *Anas platyrhyncos* certainly in the Netham-Hotwells section, would appear to be fairly sedentary and to be reliant on the river habitat for food. Gulls are, of course, highly mobile and, although feeding to some extent at outfalls or from mud, use the river as a thoroughfare and exploit feeding opportunities not connected with it or its water quality.

In his search of the literature Rose (1979) found little quantitative data relating to the Avon's birds in reports published before the 1970's. There is, therefore, no detailed ornithological information for the period when pollution of the Avon was at its worst. By comparing the few historical records with his own observations, Rose drew the tentative conclusion that the Herring Gull and the Dunlin, *Calidris alpina* had declined and that the Black-headed Gull, *Larus ridibundus* and the Redshank had increased. Without quantitative data it is difficult, however, to separate local effects from general population trends.

Data relating to changes in the invertebrate fauna of the tidal Avon might help predict changes in bird populations, but again there appears to be no information available.

Bassindale (1942) commented on the arduous conditions encountered by invertebrates in the Severn Estuary due to the extremes of salinity and the movement of silt and this is reinforced by studies carried out by Wessex Water (unpublished) near the mouth of the Avon indicating that the effects of the extreme tidal range result in a restricted invertebrate fauna.

CONCLUSIONS

Counts made between 1974 and 1987, a period when the water quality of the tidal Avon has improved considerably, do not suggest that any significant change has occurred in the bird population.

The lack of quantitative ornithological information prior to 1974 means that it is not really possible to say what changes have occurred in the period before this, when pollution of the Avon was at its worst. Dramatic differences, however, are not indicated.

Water quality is likely to continue to improve and future changes in the

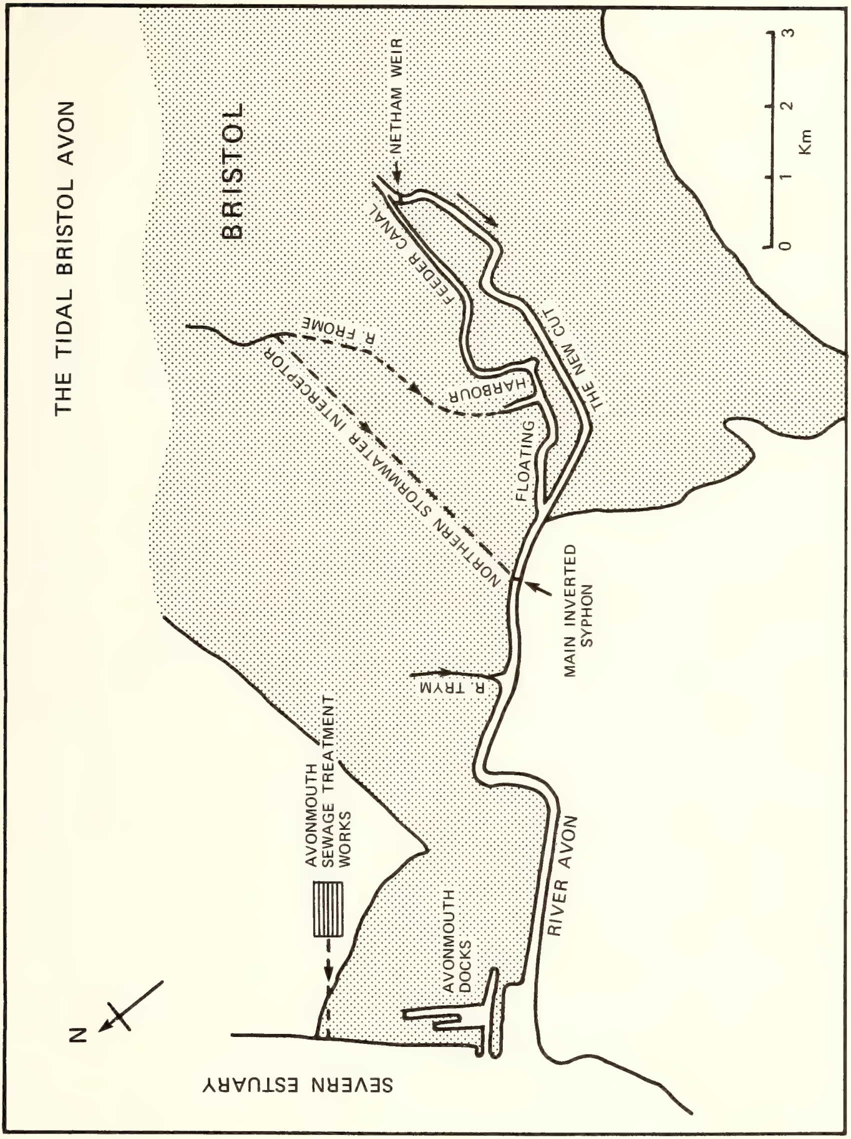
THE TIDAL BRISTOL AVON
BRISTOL
NETHAM WEIR
FEEDER CANAL
THE NEW CUT
R. FROME
HARBOUR
FLOATING
NORTHERN STORMWATER INTERCEPTOR
MAIN INVERTED SYPHON
R. TRYM
AVONMOUTH SEWAGE TREATMENT WORKS
AVONMOUTH DOCKS
RIVER AVON
SEVERN ESTUARY
N
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Figure 1. The tidal Bristol Avon.

ornithology of the river cannot be ruled out. It may well be, however, that water quality is of lesser significance in determining the ornithology of the Avon estuary and that other factors, such as the harsh tidal regime and the ability of certain species to feed opportunistically or tolerate disturbance, exert an overriding influence.

ACKNOWLEDGEMENTS

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Special thanks are due to Mr K. Gillard who 'tidied up' my sketch map and Miss P. Davies who typed the manuscript.

The theme of the paper was suggested by Mr S.M. Taylor of Bristol Naturalists' Society.

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NATURE CONSERVATION IN THE BRISTOL REGION: AN ACCOUNT OF THE WORK OF THE SOCIETY'S CONSERVATION COMMITTEE

by I.F. GRAVESTOCK

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INTRODUCTION - Why a Conservation Committee?

With nature conservation now an established feature of life, it is hard to recall that upwards of 25 years ago in the Bristol region it was more or less non-existent, without mechanism, manpower or funding. The founding of the Gloucestershire Trust for Nature Conservation (GTNC) in 1961 gave a start and, early in 1964, threats to natural history sites in north Somerset resulted in the foundation of the Somerset Trust (STNC). This led to the setting up, almost simultaneously in early 1964, of the Society's Conservation Committee, to further the cause of nature conservation in the Bristol area. Without legal status, statutory backing or funds, it worked for fourteen years to conserve valuable habitats around Bristol. Its work was not widely known and deserves to be recorded, both as a tribute to those who gave much time and energy to it and also to correct the view sometimes heard, that conservation activities in the area started only with the creation of the Avon Wildlife Trust in 1980 (Johnson, 1987). In fact, many areas in which the Trust is now interested were pin-pointed and saved for wildlife by the Committee's efforts.

The Conservation Committee was a sub-committee of Council. The area covered was defined as stretching from south of the New Grounds east to Tetbury, south along the Cotswold edge to Bath, thence to the Mendips at Cheddar, then west to Brean Down. Dr R.J.G. Savage, then the Society's President, was the first Chairman. Drawn from Council, the members were largely amateurs, in the sense that they were neither biologists nor professionals in the scientific disciplines relevant to natural history, but the Society provided access to all the specialised knowledge required. No decision was taken without a thorough grounding in the relevant disciplines or consultation with appropriate experts.

FIRST EXERCISE: THE SURVEYS OF SPECIAL AREAS

The STNC needed surveys of important habitats in order to generate a body of knowledge that could be communicated to the planning authorities when a threat to wildlife arose. Important sites in north Somerset were selected and working teams formed. The special areas and team leaders were:-

1) Clevedon-Portishead coastal strip - Mr K.T. Batty
2) Cheddar Woods and Velvet Bottom - Mr T.B. Silcocks
3) Goblin Combe - Mr D.A.C. Cullen
4) Avon Gorge and Leigh Woods - Mr P.J.M. Nethercott
5) Brockley and Bourton Combes - Mr D.A.C. Cullen
6) Gordano Valley - Mr E.S. Smith
7) Cheddar Gorge - Miss M.H. Rogers
8) Shiplait Slait - Dr T.E.T. Bond

The survey work occupied the period 1965 to 1967 and dealt not only with the natural history of the areas, but with geology, land use, amenity, archaeology, communications, education and tourist attractions. After vetting by University experts, two copies only of each report were made, to be held by the team leaders and the Society's Library, with access by the Somerset Trust as required. Extracts from the Cheddar Gorge report were published in the

Proceedings (Rogers *et al*, 1969) and later as a pamphlet.

THE SURVEY OF SEMI-NATURAL HABITATS

At the suggection of Mr C.G. Trapnell it was decided that, owing to the rapid destruction of wildlife habitats in the county, all surviving semi-natural areas should be located and recorded on 1:25000 scale maps. In this context 'semi-natural' was taken to mean woodland, scrub, heath, wetland, unimproved grassland, coastal strips and waste land. The work was organised by Dr C.E.D. Smith, who also converted the field records into the final maps, colour-coded for habitat type and supplemented by record cards giving details of important sites. Copies of these documents were lodged with the Somerset Trust, the Nature Conservancy and the county planning authorities, enabling them to identify at once any sensitive area that might be involved in planning proposals.

OTHER EARLY ACTIVITIES

These surveys and mapping schemes for the STNC were the Committee's main tasks during its first five years. It also made submissions to the appropriate authorities in connection with other matters considered important. Dr Savage attended the public enquiry on proposed quarrying at Crook Peak, which found for the objectors. The restriction of sailing at Chew Valley Lake was supported. Opposition was registered to plans for a country club at Charterhouse-on-Mendip, motor-cycle scrambling at Priddy, tree-felling in Goblin Combe and spraying at Max Bog, all of which were stopped. It held a long correspondence with the Bristol authorities over spraying on the Downs, monitored the proposed route of the M5 motorway at Michaelwood and examined schemes for quarrying at Court Hill and for quarry expansion at Backwell that posed a threat to Backwell Wood.

A WIDER PUBLIC: THE NATURE TRAILS

In late 1969 Mr K.T. Batty proposed a nature trail in Ashton Park as a contribution to European Conservation Year. The Parks Superintendent agreed with the Committee's proposal, backed by the City Museum, that the trail should be set up as a permanent feature. Field work was done by the Committee as a body, under the leadership of Mr Batty who also wrote the trail guide, which was published by the City Council. Ashton Park has much of interest, with many exotic trees, attractive open areas and old woodland. The Deer Enclosure, a timely innovation, formed a climax to the trail while another notable feature was the enormous and ancient "Domesday Oak". The trail, opened by the Deputy Lord Mayor in April 1971, became very popular and gave the Committee a more public image.

The success of the Ashton Court Trail led the Parks Department to ask in November 1971 for help in planning a nature trail in the Frome Valley and the writer was pressed into acting as organiser and author of the guide with help from the chairman and committee. This trail was more varied than that in Ashton Park; the river was an extra habitat, with its own plant and animal life, and the guide gave information on the six mills along the route, expertly documented by Mr Owen Ward. Reference was made also to Oldbury Court, adjoining the trail, and to Frenchay at its end. Illustrations were provided by Misses C. & V. Graham and the writer, as had been the case with the Ashton Park guide. The Deputy Lord Mayor opened the trail in April 1976.

FIRST BLOOD: DRUID WOOD

The end of 1969 saw a landmark in the Committee's history when it first became directly and urgently involved with a development scheme. Druid Wood at Sea Mills clothed the deep, narrow valley of a small tributary of the R. Trym. It had been zoned for residential purposes since 1950, a right of way for walkers having been lost through past neglect, but locals were astonished and dismayed when bulldozers appeared in the wood: a firm with outline planning permission to build houses and flats had started preparations before receiving full consent. Objectors had only a week or so to present their case.

The wood was small and of no more importance to the naturalist than any other urban wood. It held a good bird population; there were squirrels and badger setts, some disused, but little of note botanically and many of the trees were in poor condition. Nevertheless, and although outline planning permission had already been given, the Committee made a formal protest to the planners. Following great public outcry, the scheme was modified and much of the woodland retained, after the Committee's advice had been sought. The writer visited the wood with a representative of the landscapers, and in the outcome many features were retained; there is a pleasant woodland path but no through road, and the little stream runs into a cobbled sink.

This exercise was important because it brought the Society to the attention of the City Council, and also gave the Committee experience of the reality of conservation work - the need to operate to a stringent timetable, to have survey material ready and waiting, and to be able to propose at short notice compromises likely to be acceptable to both planners and developers. Conservation must be constructive!

COMMITTEE CHANGES

To its first three chairmen, Drs R.J.G. Savage, L.C. Frost and R.A. Avery. the Committee owed a great debt. Without their leadership it would not have been formed and would not have survived. They saw it through a period of detailed and specialised work and gave much help to the various teams through their own expertise and academic contacts. They set the standard for all that followed; members knew that each survey and each decision had to be carefully researched and evaluated. Nevertheless, as busy professionals, they could of necessity spare only limited time.

In January 1970 Mr K.T. Batty became Chairman of the Committee, and its work entered a new phase. A professional civil and electrical engineer and skilled in public relations, he was also an expert on beekeeping, had a knowledge of forestry and was a competent amateur ornithologist and geologist (1). This background enabled him to see conservation matters from the viewpoint of the general public as well as with the eye of the concerned expert. Even before he retired from his profession in 1971, he made time for many interviews with successive City Engineers, Planners and Parks Superintendents and came to know personally the key individuals. He convinced the City Planning Officer that our work would be much more helpful and effective could we but advise on proposed developments before they reached the formal stage, rather than simply registering opposition later, and this now became the pattern of operation.

There had been other changes in the Committee's membership, many of the original members having left and, at the start of 1968, Mr E.S. Smith succeeded Mrs F.R. Sterne as Secretary. Mr M.J. D'Oyley, Assistant Regional Officer of the Nature Conservancy, joined the Committee by invitation in November 1968 and, as our only professional conservationist, did yeoman service for the rest of its existence. Long-serving members were Mr D.A.C. Cullen, Mr D.W.B. Frost, Mrs A. Hollowell, Dr D.H. Peregrine, Mr F.G. Rawlings, Dr C.E.D. Smith (now Chairman of the STNC) and the writer. Other active members were Mrs N. Vaughan

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(1) Mr Batty's obituary appears elsewhere in this volume.

Davies, Miss C. Graham and Messrs H.R. Hammacott, C.H. Hurfurt, T.B. Silcocks, R.G. Symes, C.G. Trapnell and J.D.R. Vernon.

THE AVON GORGE PROPERTIES

The Avon Gorge, of international geological and botanical fame, is the most important natural history site in or near Bristol; on the Leigh Woods side it is a National Nature Reserve and for much of its length it is a geological Site of Special Scientific Interest (SSSI). In 1970 the Planning Officer alerted us to a potential development threat to properties in the Gorge, in particular Nazareth House and Bishop's Knoll. There were also fears for the adjacent Cook's Folly Wood as the Nature Conservancy had been asked by the City Corporation to reduce the extent of the SSSI in the Gorge. Accordingly, surveys were put in hand.

Cook's Folly Wood was the most important in the area, being relict Gorge Oakwood, with much *Quercus petraea* and *Tilia cordata*. Spurge Laurel, *Daphne laureola*, an indicator of ancient woodland was also present. A change from Carboniferous Limestone to Old Red Sandstone downstream changed the flora from a limestone to an acidic flora. We recommended that the wood be designated an SSSI in that area of the Gorge. The other two properties also proved to contain interesting woodland. At the lower end of the grounds of Nazareth House was an old beech wood and also a pond with freshwater snails. The builders arrived before the survey was complete, but enough had been done to allow evaluation of the area, so that the lower part of the grounds, including the wood, a marshy tract and the pond have been kept. Bishop's Knoll was a Victorian house in a commanding position in large landscaped grounds, with walled gardens and many exotic trees and shrubs. A belt of woodland beside the railway formed a useful shelter belt so we recommended that it should be retained along with the fine old trees, and this has been done. The Woodland Trust acquired the area north-west of the gardens and is planting it with trees.

INDUSTRIAL POLLUTION

In 1970 we were notified that Hallen Wood nr Avonmouth was dying due to pollution, said to be nitrous oxide from an ICI plant, which that company denied. Investigations by the NCC, GTNC and scientists from the University showed the cause to be cadmium originating from the Imperial Smelting Company. A University team monitored the distribution of cadmium deposits and their effects on local plant and animal life, with the outcome that the company had to improve emission control. The initiative in setting this work in train came solely from the Committee.

THE AVON VALLEY EAST OF BRISTOL

Early in 1971 the Planning Officer requested information on the Avon Valley east of Bristol. A survey by the Committee led to a report by Mr Batty which went to all the local authorities concerned, the NCC and the River Authority. This was used by many local schools and also by Kingswood Urban District Council when considering schemes for use of the riverside. Among valuable sites it pin-pointed was Tennant's Wood, a key site for Bath Asparagus, *Ornithogalum pyreniacum*, and Stinking Iris, *Iris foetidissima*, and this was substituted for Cleeve Wood as an SSSI.

A closely related issue was the proposed Saltford bypass along the line of the disused Midland Railway from Saltford Shallows to Kelston Park. Such a road, twice the width of the old railway, would have destroyed its rich flora and fauna. A survey by the Committee showed that the scheme could not be opposed on natural history grounds alone, but residents also opposed it. The Committee suggested to the Road Construction Unit that a decision sensibly ought to await completion of the South-West Transportation Study and assessment of the effect of the M4 motorway on the A4 traffic loading. In due course the scheme was abandoned and a cycle path was established along the old railway.

PLANS AND PLANTS AGAIN

Early in 1972, the Committee approved a suggestion by Messrs J.D.R. Vernon and M.J. D'Oyley that a vegetation survey be undertaken for the Gloucestershire part of the Committee's 'territory' on the lines of that already completed for Somerset and Mr Vernon organised volunteer members to produce maps based on surveys of 10 km grid squares which were passed to the county planning department. Motorway construction soon made some parts obsolete, and others have now been superseded by maps prepared by the Avon Wildlife Trust and others. Nevertheless the exercise inaugurated a liaison process between planners and naturalists/conservationists.

WETLAND PROBLEMS: THE GORDANO VALLEY

The Gordano Valley has presented a recurring conservation problem. In Walton and Weston Moors it held two of the few local areas having thick peat beds and, with the benefit of a high water table, there was a rich flora with five different wetland plant communities, one containing a very rare species (Willis & Jefferies, 1958). Formerly mown and grazed, large areas had by disuse reverted to semi-natural conditions; the rhines held a good flora and fauna and the valley was rich in bird and insect life. The most valuable parts were a tract on the east of Walton Drove and 10.5 ha (26 acres) of reeds on Weston Moor with the adjacent rhines. Refuse tips were operating in parts of the valley under permission given in 1956, but early in 1970 Portishead Urban and Long Ashton Rural District Councils proposed to dump household refuse on Walton and Weston Moors, raising the level by 60 cm to improve the very wet land for agriculture. The Committee and STNC put much effort into preserving the reed-bed and reminded Somerset County Council of the evidence it already held of the area's value. The bed was re-surveyed and the NCC decided to schedule part of it as an SSSI. Eventually, in 1974, 4 ha of reeds were given to STNC as a reserve, in exchange for the right to tip on an adjoining 4 ha of land. It was not possible to prevent tipping on the remaining 6.5 ha of reeds but various provisos were agreed as to its future handling after the planned cessation of tipping in 1976.

The reed bed needed periodic flooding to preserve it and the desire of local authorities and farmers to lower the water table as a means of agricultural improvement posed a new threat, enhanced by the dry summer of 1975. The Joint Committee (see below) eventually solved the problem by installing a wind-pump to feed water to the reserve. The 6.5 ha of old tip, on which a good flora is developing, and the 4 ha of reed-bed are now leased to the Avon Wildlife Trust. Although we were too late on the scene to prevent tipping altogether, at least we ensured the survival of the most valuable area and so achieved another valuable compromise.

THE WASTE LAND

At the end of 1972, Bristol Corporation proposed to tip refuse on some marshy ground at Lawrence Weston, seeing it as a convenient piece of waste land. Residents of the adjoining housing estate objected fiercely and the Vicar of Lawrence Weston asked the Society for help. We surveyed the area early in 1973. Some 18 seasonally flooded meadows bordered by relatively unpolluted rhines hold many wetland plants (including a local rarity) and butterflies are abundant. Much marshland vanished when the housing estate was developed and this attractive remnant typifies the area as it was. It is also the only sizeable tract of wetland remaining in the greater part of Bristol and the last remnant of undisturbed countryside on the north-western edge of the city. The Committee made strong representations against the tip and the scheme was dropped. The marshes remained untouched save for horse grazing, and later became an Avon Wildlife Trust nature reserve.

In 1976, the City Engineer drew our attention to a strip of waste ground at Shirehampton, between the Avon and the railway west of Lamplighters. It was 1.2 km long, held a small marshy area, and had once been a rubbish dump. On examination it was found to hold a vast range of common flowers, making a blaze of summer colour. Its value was emphasised to the City Council and it is now watched over by the Avon Wildlife Trust.

THE CHEDDAR GORGE

Four planning applications that could have proved damaging to this important SSSI were opposed by the Committee. The first, in 1965, was for a funicular railway to the top of Jacob's Ladder cliffs. This was rejected. The second, in 1973, was for a new lime-kiln to be installed in the immense working quarry at Batt's Combe and we helped to provide samples for a study by University of Bristol botanists of possible vegetation pollution in the area. The application for the kiln was approved, another instance of how hard it is to prevent extensions to an already approved scheme. The third scheme, in 1974, was for a cable-car in the Gorge, but this was refused. The fourth and last Cheddar exercise with which the Committee was concerned was a proposal by Wrington Rotary Club for a sign-posted long-distance walk along the southern cliff's from Mascall's Wood to Cheddar. Somerset County Council and the Countryside Commission were in favour, but we joined with the NCC, the STNC, the Botanical Society of the British Isles and the Mendip Society in persuading the Club to accept a revised route further from the physical danger of the cliff tops and away from the Cheddar Pinks and other rare plants there.

URBAN AMENITY: THE TRYM VALLEYS

The River Trym runs mainly through the Blaise Castle estate, which is controlled by the Bristol City parks superintendent. He requested a survey of the river valleys so as to apprise the City Council of their value. Mr Batty organised this, one of our last projects. Both valleys proved to be important over much of their length: The Westbury Trym as far as Badock's Wood, with two rare plants alongside it, and the Hazel Brook (Henbury Trym) in its steep wooded gorge as far as the Salutation Inn. Mr Batty's report covered the rivers from their joint mouth at Sea Mills. It showed that parts of both streams were showing signs of pollution and vandalism, and emphasised the need for proper management of the woodlands if their great amenity value was to be preserved. The report went to the Parks Department, all City Councillors and the Joint Committee (see below) and was available in public libraries. The Council voted £60,000 for woodland management and a Job Creation team was recruited to carry it out - a splendid example of work by amateur naturalists leading to major official expenditure!

OTHER MATTERS

LITTLETON PITS. In 1974 Bristol Waterworks Company applied for planning permission to dump slurry in one of the flooded claypits at Littleton-on-Severn.

At the behest of the Society's Ornithological Section we opposed this, on the ground that the pits were valuable both for breeding birds and as a staging point on migration. Dumping was permitted until November 3oth 1979 so long as 1 m of clear water was left above the slurry but in fact this limit was passed and the pit eventually became almost solid and overgrown with reeds. Without our intervention the pits would probably have been completely filled in and then invaded by scrub and willow. As it was, one of Avon's few reed-beds was greatly extended and is now an Avon Wildlife Trust reserve.

BODKIN HAZEL WOOD. The Committee was instrumental in securing SSSI status for this interesting wood. One of the few Avon sites for *Gagea lutea*, it also contains *Colchicum autumnale*. The wood is well maintained by its owners, the Badminton estate.

WINDSOR HILL MARSH. SSSI status was also secured for this excellent Mendip wetland, which contains two local rarities as well as orchids. It has miraculously survived, though much silted.

ROCKWELLS. This large property adjoining Kingsweston Down and formerly used by Bath University was to be developed, with demolition of the house and tree-felling in the grounds. After a survey we recommended that tree preservation orders be placed on some of the fine mature trees, and secured an undertaking that scrub would be left to provide a flightline for birds.

MIDDLE HOPE. In 1977 the possibility of creating a nature reserve at Middle Hope was discussed with the National Trust, the owners. Mr Batty mapped the area and indicated a suitable boundary. There was a large badger sett and many salt-marsh plants. The tenant farmer co-operated and access was assured. The area is now an Avon Wildlife Trust reserve.

THE LAST OPERATION FAILS

In 1976 the Land Administration Department of Bristol City Council applied for Manpower Services labour to clear the path on the left bank of the Avon through the Gorge. The object was to link the existing path from Pill with the planned path along the Avon to Bath. The only possible route, along the towpath, passed through the foot of the SSSI and of the Leigh Woods National Nature Reserve. The Committee was concerned about possible damage to the uncommon flora here during the clearing and the subsequent increased use of the path - the project leader had been unaware of the SSSI! Our suggested diversion, ascending Nightingale Valley by an existing and well-used path and descending later through Stokeleigh Forest to the old dock, was agreed to by the Planning Officer. This route avoided both the sensitive area and the very constricted length where the path came close to the vertical, concreted river bank. The NCC was consulted by the planners and agreed to the proposal "unless you consider the original route to be preferable". The obvious result was that the original plan went ahead and we felt we had lost in a worth-while cause.

However, the new path proved to be too narrow, was little used and not maintained, and was invaded by scrub growing through the landward fencing. The "Cyclebag" organisation eventually made a cycle track here, and damage has been minimised through representations from the Avon Wildlife Trust.

SWAN-SONG: THE JOINT COMMITTEE

The formation of Avon county in 1974 made the re-organisation of the local conservation interests inevitable. Discussion papers were circulated and meetings of representatives of the GTNC, STNC, this Society, Bristol Ornithological Club and Bath Natural History Society led to the formation of a Joint Committee for Nature Conservation in Avon. This had two members from each of the county trusts and one from this Society. The Committee's object was "to consult with the planning authorities to prevent unnecessary damage to and destruction of habitats of natural history importance in the County of Avon" and it was recognised that an Avon Trust would be needed in due course. Mr Batty became temporary Chairman of the Joint Committee until Mr M.J. Penistan could take over on retiring from the Forestry Commission, when Mr Batty became the Society's representative.

The Joint Committee liaised with the Avon Planning Department, working in particular with its new Landscape and Conservation Section. Much use was made of our Committee's earlier work, in particular the Trym Valleys Survey, the semi-natural vegetation maps and the Avon Valley local plan. Liaison was also maintained with the Somerset and Gloucestershire Trusts, the NCC and the Wessex Water Authority. In 1978 Mr Batty, whose health had deteriorated, resigned from the Joint Committee and also from the Chair of the Society's Conservation Committee. This latter body had now served its purpose and no successor was appointed. The writer succeeded Mr Batty as the Society's representative on the Joint Committee and became the Society's Conservation Liaison Officer, to keep Council informed of conservation issues in our area.

SUMMARY

These pages have given only an outline of the Conservation Committee's activities, but should convey an idea of the enormous volume of work, both in the field and on paper, that was shouldered for fourteen years by a very few people. The results of this service were two popular nature trails, the saving of many excellent natural history habitats and the achievement of good relations and a working co-operation with the planning departments. In fact, we had paved the way for the formation of the Avon Wildlife Trust. The gratitude of nature-lovers in Avon, South Gloucestershire and North Somerset is due to all those who helped in this work, whether their names have been mentioned or not, and this account is dedicated to them.

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A WATCH ON ORCHIDS IN THE LOWER WOODS

by M.J. PENISTAN

(The manuscript of this paper was received just after the author's death in March 1986; it was prepared for publication by M.H. Martin & S.M. Taylor.)

ABSTRACT

The later-flowering orchids, in particular the violet helleborine, *Epipactis purpurata*, have been monitored in an area of the Lower Woods, North Avon over several years. Fencing out cattle reduced, but did not eliminate, grazing damage. Trampling by cattle appears to have a large depressive effect on numbers. Individual helleborines may not appear every year but may reappear after an interval. Rosette-forming species may not appear every year, or they may appear but not flower. Some may reappear and/or flower after an interval.

INTRODUCTION

The violet helleborine, *Epipactis purpurata*, together with the broad-leaved species *E. helleborine*, appears here and there throughout the Lower Woods, sometimes in the coppices and sometimes on the wood banks around them. Hazel, field maple, birch and aspen, with some thorn (both species), sloe and crab apple form a dense canopy and there is little ground vegetation. In the 1960's, the late Hugh Giffard showed the writer several fine spikes of violet helleborine in Littley Wood (ST 74 87). Some lacked chlorophyll, having a ghostly grey-purple colour.

In the years following, the species was seen here fairly regularly and the pale form was sometimes noted over an area of some 1600 square metres. More recently the helleborine appeared to be less abundant and no pale spikes were seen. The site was open to grazing by commoners' cattle, leading to heavy poaching by their hooves so that many spikes were topped. In June 1982, a single strand of barbed wire was tied to the coppice stems at one metre above ground in order to exclude cattle from this area. It is still (at the end of 1985) effective. Its cost was met by the Conservation Fund of the Society. During this period the following observations were made:

August 1982	*Epipactis purpurata* (and possibly a few *E. helleborine*) spikes counted. Results compared with observations made by Mrs M.M.C. Reiss in an unfenced area nearby. In this and later counts the number of topped spikes was noted.
28 July 1983	All orchid plants within the wire, whether flowering or showing basal leaves only, were marked by numbered plastic pegs and roughly mapped. Besides the helleborines, there were butterfly orchids (*Platanthera chlorantha*) and spotted orchids (*Dactylorhiza fuchsii*).
27 July 1984	A more accurate survey was made and the positions of all orchids found on the 1600 sq m within the wire were plotted.
16 August 1984	A further count and plot were made. In addition, orchids on an area of some 1750 sq m immediately outside the wire were also pegged and plotted.

/cont.

The publication of this paper was generously supported by a grant from the Hector Hockey Memorial Fund.

21 August 1985 The distribution in both areas was recorded again.

RESULTS

The full data, including the plots, are too extensive to reproduce here and so a copy has been deposited in the Society's Library.

ORCHID COUNTS

Table 1 summarises numbers of the main species. For the violet helleborine, which often produces multiple spikes, the number of plants (pl) and of flower spikes (fs) are both given. All other species had one flower spike per plant. For the non-helleborine species, which produce clusters of basal leaves, the numbers in flower (fs) and with basal leaves only (bl) are given separately. In 1982, only the helleborine spikes were counted and the lack of sufficient expertise in recognition made it wise to group the two species together. For 1984, only the August totals are given. That season seems to have been a late one - in late July there were many withered remains of earlier-flowering orchids, early purple (*Orchis mascula*) and twayblade (*Listera ovata*), of which all trace had gone by the August count; also seven butterfly and nine spotted orchids emerged between 27 July and 16 August. In 1984, two bird's-nest orchids (*Neottia nidus-avis*) were found inside the wire, and two outside. In 1985 there were two inside and one outside.

(A) INSIDE WIRE

	Epipactis purpurata		*Epipactis helleborine*	*Platanthera chlorantha*		*Dactylorhiza fuchsii*	
	pl	fs	fs	fs	bl	fs	bl
August 82	- - fs = 29 - -			- - not recorded - -			
July 83	18	24	3	2	10	21	15
August 84	21	29	3	3	15	12	17
August 85	15	21	2	5	14	10	17

(B) OUTSIDE WIRE

	Epipactis purpurata		*Epipactis helleborine*	*Platanthera chlorantha*		*Dactylorhiza fuchsii*	
	pl	fs	fs	fs	bl	fs	bl
August 82	- - - - - - - - no count - - - - - - - -						
July 83	- - - - - - - - no count - - - - - - - -						
August 84	17	22	2	2	0	4	2
August 85	6	8	5	0	0	8	10

Table 1. Summary of orchid counts in Littley Wood, Avon (A) inside wire and (B) outside wire. (for explanation see text)

In July 1982, Mrs Reiss found 18 violet helleborines in an unfenced area used by cattle about 60 m from the enclosure. By August, three plants had disappeared completely and three more had been topped.

SPIKE PRODUCTION BY VIOLET HELLEBORINE

Out of 77 individual plants, 58 (75%) had one spike, 14 (18%) produced two, 2 (3%) produced three and 3 (4%) produced four, a total of 104 spikes.

There was no evidence of different behaviour in the two areas.

DAMAGE TO FLOWER SPIKES

Of the total of 135 spikes of helleborines, butterfly and spotted orchids found in the enclosure, 14 (10%) were topped. Most of these were well inside the wire. Of 51 spikes found outside the wire, 18 (35%) were affected. If Mrs Reiss' 1982 count nearby (15 *E. purpurata* spikes, three of them topped) is included, the damaged fraction is 31%.

DISTRIBUTION OF PLANTS

(a) Within the enclosure. No particular concentration of helleborines could be distinguished. One spike of the pale variety appeared each year near the same spot. In the past, specimens had been photographed in other spots within the area. Butterfly orchids tended to appear most in three localities. Spotted orchids were generally distributed. The remains of early purple orchids, when present, were in a close concentration near the centre.

(b) Outside the enclosure. The heavily poached centre of the area held few orchids of any species. Otherwise there were no noticeable patterns. The bird's-nest orchids were in the same general area in both years, but not in the same place.

PEG MARKING OF INDIVIDUAL PLANTS

The outcome of the 1983 marking of all plants inside the enclosure is summarised below for the three main species. Table 2 shows the cases where a given plant had a known outcome (in terms of presence or absence) in any two successive years.

OUTCOME		*Epipactis purpurata*	*Platanthera chlorantha*	*Dactylorhiza fuchsii*
Year 1	Year 2			
Present	Present	18 (56%)	2 (13%)	19 (46%)
Present	Absent	13 (41%)	10 (62%)	13 (32%)
Absent	Present	1 (3%)	4 (25%)	9 (22%)
Absent	Absent	4	1	1

Table 2. Known outcomes of plants protected from cattle. (Fourth category ignored in calculations)

Violet helleborine: five reappeared in 1984 and 1985, eight in 1984 only and five did not reappear in 1984, though one of them did so in 1985. Two pegs were lost in 1984 and six in 1985. The 1983 pale plant was not seen in 1984, but in 1985 one appeared elsewhere near a peg marking another species, so it presumably had been dormant for at least two seasons. There was no obvious relation between the numbers of flower spikes on a given plant in successive years.

Butterfly orchid: the flowering plants flowered again in 1984; in 1985 one did not appear and the peg of another was lost. Nine basal rosettes did not appear in 1984, and the tenth peg was lost; four of the nine reappeared as rosettes in 1985, and the other pegs were lost.

Spotted orchid: six pegs were lost in 1984 and five in 1985. Of the other 25 plants, seven appeared in all three years, two in 1983 and 1984 only, three in 1983 only, and 13 reappeared in 1985 after a year's absence. Also two rosettes appeared in 1985 where none had been visible before.

The 1984 marking of plants in the unfenced area gave very few reliable comparisons with 1985. Many of the plants found in either year were absent in the other.

DISCUSSION AND CONCLUSIONS

The first objective was to assess the effect of excluding cattle. This greatly reduced grazing of flower spikes, as would be expected, but did not eliminate it. Some spikes, well away from the boundary, were still topped, presumably by smaller animals. Flower loss need not be harmful, as it must prevent diversion of energy to seed production.

The other possible source of cattle damage is trampling. By August 1984, the enclosed plot had had two years to settle down, so a comparison of plant densities should show any effect. From Table 1, combining all four species for 1984 and 1985 together, there were 134 plants in the enclosure but only 56 on the slightly larger unfenced area. These correspond to densities of 8.4 and 3.2 plants per hundred sq m respectively.

Cattle need not be the only cause of this difference. The enclosure site was not randomly chosen but was where the pale form of the violet helleborine had been seen earlier, so there might have been some intrinsic difference in the two areas. Against this are the following points. The areas adjoin and appear similar. In the unfenced area numbers varied greatly from year to year and its central half, which was heavily poached, held few orchids of any species. In 1982, Mrs Reiss noted that three out of 18 violet helleborines disappeared between July and August in a nearby trampled area. All this points to trampling as a major cause of the orchid deficit in the unfenced area.

The second objective, to learn more of the numbers and distribution of the pale form of violet helleborine, was not achieved since only one was seen each year. Spikes had been seen and photographed in other spots in the enclosed area in past years.

The third objective was to learn something of the season-to-season appearance of individual plants from the placing of numbered pegs. From Table 2 it can be seen that some 40% of the violet helleborines and spotted orchids, and 80% of the butterfly orchids present in one year did not reappear in the next, but some did so after a year's absence. Other plants appeared in places where none had been seen for at least two years.

Every whole helleborine stem that was seen carried flowers. Table 1 shows that only about one in four butterfly orchids and half the spotted orchids did so.

According to Summerhayes' *Wild Orchids of Britain* (1962) there is a tendency for the number of flower spikes produced by a violet helleborine plant to increase with age. No evidence of this was found, perhaps because of past disturbance by trampling.

ACKNOWLEDGEMENT

Help in this study was given by Mrs P.J.E. Woodbridge.

Morley J. Penistan was a member of this Society from 1975 until his tragic death in a road accident on 5 March 1986. A forester by profession, he held high office in the Forestry Commission. He will be particularly remembered for his services to nature conservation in Gloucestershire; latterly he served for many years as Chairman of the Gloucestershire Trust for Nature Conservation, of which he was a founder member. As recently as July 1985 he was joint leader of a meeting of the Society to Bays Wood, Horton, an area near his home which he knew and loved.

On 18 October 1987, Frith Wood, Bull's Cross, Chalford, was bought by the GTNC using the proceeds of his memorial fund and named "Frith Wood - the Morley Penistan Memorial".

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THE ORIGIN AND SURVIVAL OF JUVENILE ASH STANDS

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ABSTRACT

Stands of juvenile ash saplings, in long-established broad-leaved woodlands, are composed of even-aged populations with a natural life-span of twenty to twenty five years. Following degeneration, the old population is rapidly replaced by a pre-existing but younger seedling/sapling understorey, also even-aged. Evidence is provided to show that the origin and rhythm of replacement of several populations may have been the cessation of coppicing some seventy to eighty years later.

INTRODUCTION

In deciduous British woodlands, a common component of the shrub layer is a stand of ash (*Fraxinus excelsior* L.) saplings often not more than 1-2 m high and surviving for many years, in what has been described as a stagnant condition (Wardle, 1959). Gardner (1975) examined one such colony in a Derbyshire ash wood and noted the age of a single stand of saplings. Ranging from 15 to 28 years, 62% of the population were 21-24 years old. Gardner proposed that the origin of this relatively even-aged population was a single event which had taken place 22 years earlier; and which provided exceptional conditions promoting survival of seedlings which had already germinated or were to germinate shortly after. The exceptional event was considered to be the removal of a mature tree in the centre of the survey area, resulting in increased solar irradiance at ground level. Gardner believed that his 22-year-old colony might well survive for many more years (Gardner, 1975). There is, however, an alternative possibility, that even-aged sapling populations do not survive beyond a certain age and that as that certain age is reached, the old population is rapidly replaced by an even-aged younger population and that this occurs without the aid of a further exceptional event. The questions raised than are these: what are the origins of even-aged stands of saplings and for how long do they survive?

To answer these questions, a number of discrete populations of ash saplings have been monitored for several years under field conditions.

METHODS

The field site was the Wetmoor Nature Reserve, a 13 ha ancient damp-oak woodland owned and actively managed by the Gloucestershire Trust for Nature Conservation and forming the central portion of the 300 ha Lower Woods, Ingleston, Avon, South England (grid reference ST 745 877). The biology of the reserve has been fully described (Hendry, 1980) as has its historic and recent management (Hendry *et al.*, 1984). The woodland is composed of maturing oak (principally *Quercus robur* L. with some *Q. petraea* (Liebl.) mostly planted between 1870 and 1895. Ash, birch (*Betula* spp.), beech (*Fagus sylvatica* L.), hybrid poplars (*Populus* spp.) and *Sorbus torminalis* (L.) Crantz make up the minor component of the tree canopy. The shrub layer, principally hazel (*Corylus avellana* L.), maple (*Acer campestre* L.) and hawthorn (*Crataegus* spp.) was managed as coppice until about 1910-1914, latterly on a 15-20 year cycle (Hendry, 1980). After this period, management was abandoned and the density of the standards, particularly ash, increased. In 1970-71 regular and controlled coppicing was resumed for conservation purposes. Significant efforts to reduce the stocking density of standards to below 200/ha were begun in 1977-78 (Patrick & Hendry, 1982). In June 1979, a survey of ash saplings (referred to as Survey I) was conducted in three areas of the woods not subject to modern-day coppicing (sites A, B and C) and in four sites coppiced at known dates during the preceding eight years (sites E, F, G and H). Seven years later, also in June, the sapling at each site were re-surveyed (Survey II), together with an additional coup (site J). The surveys were conducted by selecting at random two ash saplings 2.0 m apart in the approximate centre of a sapling colony. The nearest four saplings lying at right angles 2.0 m away from a line drawn between the first two samples were also selected. The height of the six (occasionally five) selected saplings was noted as was the growth condition of the leader. The basal 50 mm of the sapling stem was then removed for dating by ring counting. The only ash saplings ignored in both surveys were those few measuring 25 cm or less (5 saplings aged 4 to 7 years). Saplings which appeared to be developing into trees (as in site J) were included.

RESULTS

The surveys are summarised in Table 1. The data show that the ages of the saplings from the three uncoppiced sites (A, B, C) were, in 1979, 23.0 ± 1.6, 22.0 ± 1.5 and 18.8 ± 2.0 years and giving a relatively even-aged population of 21.4 ± 2.5 years. If this population were to behave as suggested by Gardner (1975), then seven years later the age of the population should have risen to 28 years. Table 1 shows that in 1986 the population was still even-aged but with a mean of only 16.4 ± 2.7 years. Not one member of the 1979 population could (with 95% confidence) have been present in the 1986 survey. The interpretation is that an event occurred after 1980 which wiped out the 1979 population and allowed the rapid development of a new, younger, population. The existence of the younger population was not detected in 1979, presumably because the individuals were less than 25 cm high.

Evidence that the 1979 population might have been failing was noted by the high (82%) number of individuals with a dead leader. In contrast the younger 1986 sample had only 50% with a dead leader.

In the coppiced areas, four coups (E, F, G and H) were surveyed in 1979. The mean ages of the ash saplings were 17.0 ± 0.5, 16.7 ± 1.9, 13.3 ± 0.9 and 12.3 ± 1.3 years and appear to be progressively younger in the more recent coups. Seven years later, however, the colonies in the four coups were aged at 13.3 ± 1.0, 12.8 ± 1.0, 13.3 ± 2.1 and 11.0 ± 1.3 years. Once again the entire older population appears to have been eliminated and replaced by younger individuals after 1980. There was, however, no marked evidence of exceptional leader die-back in the coup population.

The replacement of all the 1979 populations by younger saplings in all areas examined was unexpected. Casual observation in the intervening years suggested that the colonies were healthy and showing annual increases in height. Up to 1979, the mean annual height increment of colony A was 40.9 mm. Only when Survey II showed that this value had increased to 62.9 mm between 1979 and 1986 did it become apparent athat the old and probably degenerate colony had been replaced. This was confirmed by ring-count data.

The conclusion is that undisturbed even-aged stands of ash saplings are subject to elimination and probable simultaneous replacement by younger even-aged stands which rapidly and vigorously expand to fill the gap left by the older colony.

ORIGINS OF EVEN-AGED POPULATIONS

Figure 1 records, schematically, the life histories of the populations existing in 1979 (suffix I) and in 1986 (suffix II). The individual colonies

Site	Site description	Sample population		Age (yrs)		Height (m)		% dead leaders	
		1979	1986	1979	1986	1979	1986	1979	1986
A	River terrace, alluvial soil pH 6.6	6	6	23.0 ± 1.6	16.3 ± 3.3	0.94 ± 0.32	1.38 ± 0.21	67	33
B	8° incline, clay with limestone pH 6.0	5	6	22.0 ± 1.5	17.3 ± 1.6	1.14 ± 0.33	1.26 ± 0.24	100	67
C	Plateau, clay pH 4.3	5	6	18.8 ± 2.0	15.7 ± 3.1	1.06 ± 0.48	1.20 ± 0.26	80	50
	Totals from dense shade sites	16	18	21.4 ± 2.5	16.4 ± 2.7	1.04 ± 0.44	1.28 ± 0.24	82	50
E	Coup 1970-71 + 72-73 pH 4.7	6	6	17.0 ± 0.5	13.3 ± 1.0	1.20 ± 0.49	1.46 ± 0.45	67	67
F	Coup 1974-75 pH 4.1	6	6	16.7 ± 1.9	12.8 ± 1.0	0.72 ± 0.38	0.93 ± 0.41	33	14
G	Coup 1975-76 pH 4.7	6	6	13.3 ± 0.9	13.3 ± 2.1	0.70 ± 0.30	1.05 ± 0.19	0	67
H	Coup 1976-77 pH 4.9	6	11	12.3 ± 1.3	11.0 ± 1.3	0.41 ± 0.23	0.84 ± 0.32	100	64
J	Coup 1977-78 pH 5.0	-	6	-	10.2 ± 1.7	-	1.84 ± 0.64	-	0
	Totals from coppice areas	24	35	15.3 + 3.6	12.0 + 1.9	0.84 + 0.48	1.17 + 0.53	50	43
	Total from all areas	40	53	18.4 + 4.3	13.5 + 3.9	0.73 + 0.47	1.21 + 0.53	50	43

Variance is expressed as one standard deviation. Soil pH from Hendry (1980).

Table 1. Age and status of eight ash-sapling colonies.

(A to H) in Survey I appear to arise approximately every two years. The origins of these colonies is, however, not known. During the 1950's and up to 1965 the woods were effectively unmanaged, unfenced, the coppice greatly overgrown and with no commercial exploitation of the standards.

In the winter of 1970, coppicing recommenced at a site close to E and about 150 m from C. In 1971-72, coup D (not included in the survey) was formed 50 to 75 m from C. Colonies A_{II}, B_{II} and C_{II} were established about this time (Figure 1). The colony E_{II} and the adjoining colonies F_{II} and G_{II} were established within a year or so of 1972-73. The coppicing of sites F and G took place in the winters of 1974-75 and 1975-76 when the adjoining populations H_{II} and J_{II} were first established.

From 1977, management policy towards coppicing altered with a decision to reduce significantly the standard stocking density to below 200/ha. This event had its impact on coup J and appears to explain the remarkable growth of that sapling stand (mean height 1.84 m in eight years). Earlier coups meanwhile had become rapidly shaded by the high density of both standards (up to 340/ha) and hazel stools (up to 1027/ha) (Patrick & Hendry, 1982) and do not show such large height increases. Despite the considerable variation in height, however, it appears that all of the Survey II colonies in the coups E to J owe their origin to coppicing in the same or an adjoining area and follows from the improved ground-level irradiance (Patrick & Hendry, 1982) and probable increased distribution of wind-blown ash seeds. It is also possible that colonies of A_{II}, B_{II} and C_{II} owe their origin to the resumption of coppicing. It is unlikely, however, that this was due to enhanced irradiance at C (even less at A or B), C being 50-75 m from the nearest coup. A more likely explanation perhaps is an increased distribution of ash seeds into areas A, B and C. These areas lie directly in line with the prevailing SW winds. Wardle (1959) states that ash seeds are wind-carried for up to 125 m (though presumably less in mature woodlands.

All of the colonies A_{II} to H_{II} would, in 1979, have co-existed beneath the older, taller stands A_I to H_I, then 12-23 years old and showing evidence of increasing leader die-back. All of the colonies A_I to H_I disappear on or after 1980 and, from casual field observations, before 1984. Locally, the winters of 1981-82 and 1982-83 were among the most severe in the region since 1963 and 1947. Heavy snowfalls in March 1982 brought down several mature trees in the reserve. It is suggested that one or both of these exceptional winters wiped out all of the older sapling stands A_I to H_I and leaving no trace at least among the 53 samples taken in 1986. These harsh winters appear to have had no effect on the younger stands A_{II} to H_{II} which have exploited the destruction of the old population by rapid growth.

The pattern of annual, or biennial, establishment of each component colony in Survey II broadly mirrors that of population I (Table 1), possibly a coincidence. However, the order of establishment of population I is also remarkably similar to population II as is the sequence which moves annually (or biennially) from north to south (or river plain to level plateau). Now, if it is accepted that population II arose in association with an ordered sequence of annual coppicing (co-incidentally also on a north-south axis), it is interesting to speculate that population I also arose in response to an earlier N to S coppice sequence. (A linear south to north coppice cycle was practised on the neighbouring Badminton Estate in the 19th and 20th centuries (Hendry *et al.*, 1984)). Although coppicing ceased before 1914, 40 to 60 years before the establishment of population I, the rhythm of germination, development and senescence alongside a 15-20 year coppice rotation may have imposed a similar rhythm on subsequent generations long after the cessation of coppicing. If, as is suggested here, the life of an ash sapling is about 20-25 years, then population I would represent the third or fourth generation of saplings since the end of commercial coppicing before the First World War.

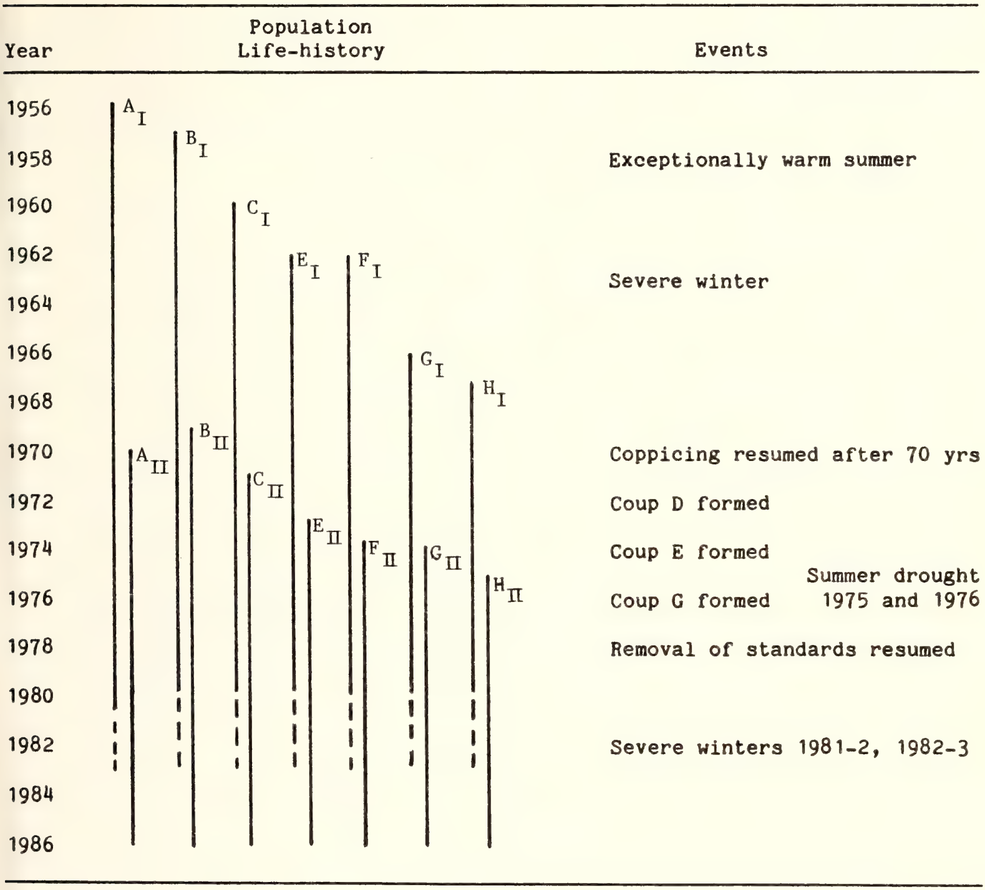

Figure 1. Chronology of origin and survival of seven juvenile ash stands surveyed in 1979 (I) and 1986 (II). Dotted lines indicate probable period of death.

CONCLUSION

The characteristic stands of juvenile ash saplings to be found in long-established broad-leaved woods, are composed of discrete but even-aged colonies. These colonies appear to have a natural life span of about 20 years, when the population collapses. Rapid replacement of the old population takes place by a pre-existing younger seedling/sapling understorey which may also be even-aged. The cycle of ageing and replacement may take place without the intervention of exceptional events. However, the origin and sequence of development of each discrete colony might once have been due to an exceptional event (such as coppicing or standard removal) which took place many years earlier and which has affected the development and rhythm of ash sapling populations for several subsequent generations.

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ON THE IDENTITY OF A CRYPTOGAM HERBARIUM IN BATH GEOLOGICAL MUSEUM

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INTRODUCTION

During studies on the lichen flora of the Bristol region, an unnamed collection of cryptogamic plants was located in the Bath Geological Museum store. This paper details the evidence used to deduce that this collection of some of the earliest lichen records from the region was made by Mr C.E. Broome and lists and identifies the lichens collected in the Bristol/Bath region.

THE HERBARIUM

The lichen collection consists of 5 bundles containing herbarium sheets onto which are glued 1026 specimens dating from 1822 to 1883. Many specimens are derived from *exsiccatae*, others from identified collectors and some, particularly from the Bristol/Bath region, are unauthenticated. The latter are presumed to be collections made by the herbarium compiler and represent some of the earliest lichen records for the region. Specimens also come from France, Italy, Australia, India, Sri Lanka, Jamaica, U.S.A., as well as many parts of Great Britain.

The Bath Geological Museum and Library contains records of the Bath Royal Literary and Scientific Institute (BRLSI) (1822-1936) in which there are references to the "Jenyns-" or "Jenyns-Broome Herbarium". The BRLSI minutes (Vol. V 13/12/1886) refer to the donation of Mr C.E. Broome's collection of flowering plants, mosses, lichens and algae bequeathed in his will with all his books initialled "CEB". Because Rev L. Jenyns (who changed his name to Blomefield in 1871) and Mr C.E. Broome frequently collected together, it is difficult to separate their individual contributions to the flowering plant herbaria present in Bath (Blomefield, 1889). In the 1920's, Surgeon Commander H.C. Arathoon, and to a lesser extent Mr T.H. Green, conducted a "relabelling and classifying" programme on the flowering plant collection but, apart from the BRLSI minute (8/2/1892) requesting a Miss Broome (perhaps his daughter) to arrange a box of mosses and lichens, no further mention of the moss and lichen collections occurred until Dr E.W. Jones reported (29/4/1977) the existence of these unnamed herbaria in a report to the Museum.

EVIDENCE THAT THE COLLECTION BELONGED TO C.E. BROOME

SITES AND DATES

Christopher Edmund Broome was born at Berkhampsted in Hertfordshire on 24th July, 1812. Specimens in the herbarium date from 1822-1883. Early specimens from 1820-25 are from Bottisham, Cambridgeshire, as are 57 loose packets with a note calling them "Cambsh. Lichens" "to C.E. Broome Esq, Elmhurst, Batheaston". In 1832 he had gone to study for the church at Swaffham Priory, Cambs. and had become slightly acquainted with Rev L. Jenyns who was vicar of Swaffham Bulbeck from 1828-49. However, in October 1832, Broome entered Trinity Hall Cambridge, took his degree in January 1836 and, after marrying Charlotte Horman in April 1836, moved to Rudloe Cottage, Box, near Bath. There are no lichen specimens dating from this period but a number of mosses were collected from Rudloe between February 1838 and April 1843.

In 1844 Broome moved to Wraxall Lodge, nr Bristol, from which there are moss specimens of *Weissia cirrata*, 1844 and *Dicranum glaucum*, January 1845. After only 9 months he moved to Clifton, Bristol where he appears to already have been acquainted with the eminent botanist G.H.K. Thwaites. It is probable that he joined Thwaites on botanical excursions with other respected botanists visiting Clifton. A number of specimens collected in the Bristol region in April 1847 are attributed to the Sussex botanists W. Borrer (lichens) and W. Mitten (bryophytes and one lichen). Among the specimens initialled G.H.K.T(hwaites) are specimens of *Synalissa vulgaris*, first found and described by Thwaites on St. Vincent's Rocks in the Avon Gorge (Thwaites, 1849). Thwaites also discovered the moss *Grimmia orbicularis* in the Avon Gorge; specimens are present and initialled in the herbarium. A specimen of *G. orbicularis*, initialled "W.G.", links Broome with W. Gardiner (Dundee) who sent many moss and lichen specimens from Scotland during the 1841-43 period. Thwaites moved to Ceylon in 1849 but continued to correspond with Broome and sent him Ceylonese specimens of *Strigula nemathosa* and *S. feei*. Because there are local specimens dated after this time, the herbarium could not have belonged to Thwaites.

In 1848 Broome moved, for the last time, to Elmhurst, Bath. When Rev L. Jenyns moved in 1850 to Southstoke, 4 miles away across Combe Down from Elmhurst, the two soon began to make regular Thursday excursions to study the local natural history. These excursions were the progenitors of the Bath Natural History and Antiquarian Field Club (BNHAFC), founded on 18th February 1855 with L. Jenyns as the first president. Many lichen specimens were collected in and around Elmhurst during 1850-56 with a peak in January/February 1856.

The Shrewsbury lichenologist Rev W. Leighton visited Bath and stimulated Broome to study lichens (many specimens have pencil drawings and measurements of spores). There is a specimen in the herbarium of *Bacidia rubella* collected by Rev Leighton from Bathford in January 1856. Many lichens in the collection are from Leighton's *exsiccata*, issued between 1851 and 1867, distinguishable by their numbering and typed format. Those from Twycross and Gopsall derived from Rev A. Bloxham (one time rector of Twycross, Leicestershire) who also sent a specimen of *Strigula babingtonii* direct to Broome. There are also some specimens derived from a number of Italian *exsiccatae*, probably provided following Broome's visit to Italy (Blomefield, 1889). Independent evidence (Rendle, 1931) confirms that Broome was also in contact with S. Ralfs (lichens) and W. Curnow (mosses) from Cornwall and F.H. Bailey from "Brisbain", Australia; the herbarium possesses specimens from all these sources.

Broome's main scientific contribution was on fungi, in collaboration with Rev M.J. Berkeley. Their correspondence started in 1841 and continued until Broome's death in 1866. They jointly named and described a number of species, a full list of their publications being given in *Annals of Botany* 3, 451-456 (1889-1890). Fungal specimens also come from Elmhurst. Broome's enthusiasm for micro-fungi is reflected in the large number of crustose and micro-lichens, apparently collected by him, rather than the showier macrolichens.

Although a number of the botanists mentioned above were competent to have compiled these herbaria, other evidence argues against this.

HANDWRITING

The handwriting in pencil is the same throughout the bryophyte, lichen and fungal collections. Most of Thwaites specimens and some from Gardiner are in ink in the same script. One fungal specimen is initialled "CEB" in this script and the initials are identical to those in books donated by Broome. The majority of Broome's fungal specimens are at the British Museum (Natural History), London and comparisons have shown that the handwriting is identical.

This ensures that the Bath handwriting was not by a later hand and comparisons with authentic handwriting of L. Jenyns and H.C. Arathoon show clear differences. The identification of the handwriting as being Broome's is further supported by an unsigned and undated lecture given by Broome to the BNHAFC.

Other handwriting in ink is (a) on all Nylander specimens (probably Nylander's, except for pencilled additions in Broome's hand), (b) a different, bold, script on specimens possessing *exsiccata* numbers (probably Leighton's script) and (c) Miss Lonsdale's specimens (her name in pencil).

PUBLISHED RECORDS

The herbarium contains a specimen labelled in the usual pencil handwriting "*Calicium curtum* on rails nr. Batheaston, Jan 1852", without indication of collector. This is important because in Leighton's *Lichen Flora* (1st - 3rd editions: 1871, 1872, 1879) a specimen is reported as "Batheaston! Mr. Broome". The '!' indicates it had been seen by Leighton and the specimen preserved here may be the actual one referred to.

Watson (1930) mentions a specimen of *Acrocordia gemmata* in the British Museum as deriving from "Batheaston (Broome 1856)". There is also a specimen in the present herbarium with the same date and location.

LOCAL RE-IDENTIFIED SPECIMENS

The appendix shows the identity of 92 species whose identity has been checked. Both the current and originally used name are presented and this shows that the majority of specimens were correctly identified, changed nomenclature only reflecting modern taxonomic concepts. Most specimens are of common species which still occur in the district. However, *Solorina saccata* has not been recorded from Leigh Woods in recent years and this probably reflects the much more open nature of the wood at the time of collection. By comparison with the details in Watson's *Flora of Somerset* (1930), the lichen herbarium is of interest in that most of the specimens represent the earliest reports of these species from Somerset. Although Knight's *The Lichens of Gloucestershire* (1950) does not quote the dates of the earliest records, it is unlikely that many are significantly earlier than for Somerset. The appendix shows the dates of the records and indicates those species with earlier reports. Early records for Vice County 6 in Watson (1930) refer to the herbarium of E. Forster (1765-1849) purchased by Robert Brown and presented to the British Museum in 1849. It is interesting that Watson (1930) mentions that H.B. Holl collected lichens in N. Somerset about 1866 and these are generally from Batheaston. It is not known whether Holl and Broome met, but it appears very likely.

ACKNOWLEDGEMENTS

We are grateful to Mr R.F. Pickford of the Bath Geological Museum for his valuable assistance and for arranging access to and loan of the herbarium and to Mr D. Reid of the Herbarium at Kew Royal Botanic Gardens for photocopies of Broome's handwriting.

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APPENDIX: Identity, locations and original names of local lichens in the Broome Herbarium.

Nomenclature follows Hawksworth *et al.* (1980), with some later additions.

+ = Species not recorded in Watson (1930) from vice-county 6
* = Species recorded earlier than present records.

Acrocordia conoidea (Fr.) Körber[1]: BD[2]'56[3], BfH'56. (*Verrucaria epipolea*[4] (2))

A. gemmata (Ach.) Massal.: E'56, SP'50. (*Verrucaria gemmata; Verrucaria ?*)

+ *A. salweyi* (Leighton ex Nyl.) A.L. Sm.: Be'56. (*Sagedia viridula*)

Anisomeridium biforme (Borrer) R.C. Harris: E. (*Verrucaria biformis*)

Aspicilia calcarea (L.) Mudd: BD(2)'56, Bf'56, DD'44T[5]. (*Parmelia cirerea?*; nn[6] (2); *Urceolaria calcarea*)

A. contorta (Hoffm.) Krempelh.: BD'56. (*Parmelia glaucina*)

Bacidia sp.: Be (nn)

* *B. bagliettoana* (Massal. & de Not.) Jatta: Be (2) '56/'57. (*Biatora muscorum; Lecidea viridescens?*)

B. ?naegelii (Hepp) Zahlbr.: BfH. (*Biatora vernalis*)

B. rubella (Hoffm.) Massal.: Bf'56L, BfH'56, KW'44T. (*Biatora luteola* (2); *Lecidea vernalis*)

B. sabulatorum (Schreber) Lettau: S'47M. (*Biatora uliginosa*)

Buellia punctata (Hoffm.) Massal.: S'47B. (*Lecidia pineti*)

Calicium abietinum Pers.: nr Be. (*Calicium curtum?*)

+ *C. glaucellum* Ach.: Shockerwick. (*Calicium*)

+ *C. saliciunum* Pers.: BD. (*Calicium*)

C. viride Pers.: KW'44T. (*Calicium hyperellum*)

Caloplaca cerina (Ehrh. ex Hedw.) Th. Fr.: KW'44T. (*Lecanora cerina*)

C. flavescens (Huds.) Laundon: BfH (2) '56, DD'44T. (nn (2); *Squamaria murorum*)

C. holocarpa (Hoffm.) Wade: BD (2) '56(L?). (*Biatora erythrilla; Parmelia*)

C. saxicola (Hoffm.) Nordin: BfH'56. (*Parmelia murorum*)

Candelariella aurella (Hoffm.) Zahlbr.: Bf'56. (*Parmelia*?)

+ *Catapyrenium lachneum* (Ach.) R. Sant.: BfH'56, C'44, LW'47B, S (2) '44T/'47, SVR'44T. (*Endocarpon pusillum; E. hedwigii; E. lachneum; E. rufo-virescens* (2); *E. hedwigii*)

Cladonia coccifera (L.) Willd.: SP'69. (*Scyphophorus cocciferus*?)

C. fimbriata (L.) Fr.: H. (nn)

C. floerkeana (Fr.) Flörke: SP'69. (*Scyphophorus*)

C. furcata (Huds.) Schrader: nr B'44T. (*Cladonia furcata*)

C. parasitica (Hoffm.) Hoffm.: S'47B. (*Cladonia caespiticia*)

C. polydactyla (Flörke) Sprengel: Shapwick. '56. (nn)

C. pyxidata (L.) Hoffm.: Miss Lonsdale. (*Scyphophorus pyxidatus*)

C. rangiformis Hoffm.: H. (nn)

Cliostomum griffithii (Hagen) Coppins: E'56. (*Lecidea punctiformis*

* *Collema auriforme* (With.) Laundon: LW'47B (+NGV'47B), SVR'45. (*Collema auriculatum; C. dermatina; C. turgidum*)

C. crispum (Huds.) Wigg.: nr B'47B. (*Collema crispum*)

C. fragrans (Sm.) Ach.: S (2) '47B. (*Collema fragrans* (2))

C. multipartitum Sm.: SVR'44T. (*Collema multipartitum*)

* *C. tenax* (Swartz) Ach.: SVR'47. (*Collema*)

+ *Coniocybe furfuracea* (L.) Ach.: S'47B. (*Calicium furfuracea*)

* *Dermatocarpon miniatum* (L.) Mann: C'44, SVR'44T. (*Endocarpon miniatum* (2))

Diploicia canescens (Dickson) Massal.: nr B'44T, Be'56. (*Placodium canescens; Parmelia canescens*)

Diploschistes muscorum (Scop.) R. Sant.: BfH'56. (*Parmelia scruposa*)

D. scruposus (Schreber) Norman: Bf. (*Parmelia scruposa*)

Diplotomma alboatrum (Hoffm.) Flotow: BD'56, nr B'44T (nn; *Lecidea albo-atra*)

D. chlorophaeum (Hepp. ex Mill. Arg.) Szat.: SP'57. (*Lecidea lapicida*)

Enterographa crassa (DC.) Fée: LW'44T. (*Pertusaria crassa*)

Graphis scripta (L.) Ach.: Be'50. (nn)

+ *Huilia albo-caerulescens* (Wulfen) Hertel: Bf'56, BfH'56. (*Myriosperma heppii?; M. pruinosa*)

Hypogymnia physodes (L.) Nyl.: nr B'44T. (*Parmelia physodes*)

Lecanactis abietina (Ach.) Körber: S'47B. (*Verrucaria leucocephala*)

Lecanora atra (Huds.) Ach.: BD (2) '56, nr B'44T. (nn; *Parmelia*; *Lecanora atra*)

L. campestris (Schaerer) Hue: BD'56. (*Parmelia saxicola?*)

+ *L. chlarotera* Nyl.: E'56, nr B'44T. (*Parmelia subfusca*; *Lecanora subfusca*)

L. dispersa (Pers.) Sommerf.: BD (2) '55/'56. (*Parmelia hageni*; *Lecanora hageni*)

Lecidea immersa (Hoffm.) Ach.: Bf'56, BD (2) '56. (*Lecidea immersa* (2?); *Lecidea*)

L. monticola (Ach.) Schaerer: BfH'56. (*Lecidea confluens*)

+ *L. ?turgidula* Fr.: SP'51. (*Lecidea incompta*)

Lecidella elaeochroma (Ach.) Choisy: nr B'44T, Be'56, BfH (2) '56L, E'56, SP (2) '50/'51. (*Lecidea elaeochroma*; *Lecidea parasema* (5); nn)

Leproplaca xantholyta (Nyl.) Hue: Bfh'56. (*Parmelia fulgens?*)

Leptogium gelatinosum (With.) Laundon: SVR. (*Collema sinuatum*)

+ *L. lichenoides* (L.) Zahlbr.: nr B. (*Collema pulvinatum*)

L. schraderi (Bernh.) Nyl.: SVR'49. (*Collema schraderi*)

Ochrolechia parella (L.) Massal.: nr B'44T. (*Lecanora parella*)

Opegrapha atra Pers.: nr B'44, Be (3) '51/'52/'56, E'51. (*Opegrapha atra* (3); nn; *Opegrapha*)

+ *O. cinerea* Chev.: Be (2) '51/'56, LW'44T. (*Opegrapha atra*; *Opegrapha vulgata* (2))

+ *O. prosodea* Ach.?: Miss Lonsdale. (*Opegrapha scripta*)

O. saxatilis DC.: BD'56, SVR'47T. (*Opegrapha saxatilis*; *Opegrapha*)

O. varia Pers.: LW'45T. (*Opegrapha varia*)

Parmelia glabratula (Lamy) Nyl.: nr B'44T. (*?Parmelia olivacea*)

P. subaurifera Nyl.: nr B'44T. (*?Parmelia olivacea*)

P. sulcata Taylor: nr B'44T. (*Parmelia sulcata*)

Pertusaria hymenea (Ach.) Schaerer: Be'56. (*Pertusaria wulfenii*)

Phaeophysica orbicularis (Necker) Moberg: nr B'44T. (*Parmelia cycloselis*)

Physcia stellaris (L.) Nyl.: E'56. (*Parmelia stellaris*)

Physconia pulverulacea Moberg: nr B'44T, E'56. (*Parmelia pulverulenta*; *Parmelia stellaris*)

Placynthium nigrum (Huds.) Gray: BD'56. (*Parmelia triptophylla*)

Protoblastenia calva (Dickson) Zahlbr.: BD'56, DD'49T. (*Biatora rupestris?*; *Lecidea rupestris*)

P. rupestris (Scop.) Steiner: Bf'56. (*Lecidea rupestris*)

Pyrenula macrospora (Degel.) Coppins & P. James: LW'44T, SVR'47B. (*Verrucaria nitida*)

Pyrrhospora quernea (Dickson) Körber: nr B'44T. (*Lecidea quernea*)

Ramalina farinacea (L.) Ach.: nr B'44T. (*Ramalina farinacea*)

R. fastigiata (Pers.) Ach.: nr B'44T. (*Ramalina fastigiata*)

R. fraxinea (L.) Ach.: nr B'44T. (*Ramalina fraxinea*)

* *Solenopsora candicans* (Dickson) Steiner: BD'56, DD'44T. (*Parmelia candicans*; *Squamaria candicans*)

Solorina saccata (L.) Ach.: LW'47B. (*Solorina saccata*)

Squamarina cartilaginea (With.) P. James: DD'54, SVR'44T. (*Squamaria crassa*)

Synalissa ramulosa (Hoffm.) Fr.: SVR (2) '49T. (*Synalissa vulgaris*)

Thelidium decipiens (Nyl.) Krempelh.: Be. (*Verrucaria*?)

T. incavatum Nyl. ex Mudd: BfH'56. (*Verrucaria*)

+ *T. papulare* (Fr.) Arnold: Bf'56, Bfh'56L. (*Verrucaria trachona* (2))

+ *Toninia caeruleonigricans* (Lightf.) Th. Fr.: Be'55, Bfh'57, SVR'44T. (*Psora caeruleo-nigricans*; *Lecidea vesicularis* (2))

Verrucaria muralis Ach.: BfH'56. (*Verrucaria muralis*?)

Verrucaria nigrescens Pers.: BD'56, SVR'47B. (*Verrucaria nigrescens*?; *Verrucaria microsticta*)

+ *Verrucaria viridula* (Schrader) Ach.: BfH (2) '56. (*Verrucaria*; nn)

Xanthoria parietina (L.) Th. Fr.: nr B'44T. (*Parmelia parietina*)

Unidentifiable: Bf *Pertusaria*?; S *Collema*?; SVR'45T *Collema multipartitum*, *Collema* "(young)".

1 = Current name

2 = Location: BD = Banner Down; Be = Batheaston; Bf = Bathford;
Bfh = Bathford Hill; c = Cheddar; DD = Durdham Down;
E = Elmhurst; H = Hanham; KW = Kingsweston Park;
LW = Leigh Woods; nr B = near Bristol; S = Stapleton;
SP = Spye Park; SVR = St. Vincents Rocks.

3 = Year in 19th century.

4 = Name used on original sheets.

5 = Name of collector: B = Borrer; L = Leighton; M = Mitten; T = Thwaites.

6 = No name given to original specimen.

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1) Original papers will be considered for publication if they contain material of relevance to the natural history of the Bristol region.

2) The copyright of all published matter shall be the property of the Society, whose Council has power to permit reproduction.

3) Manuscripts should be double-spaced with ample margins. A copy should be retained by the author(s).

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5) The style and conventions of the *Proceedings* must be followed in relation to headings and the citation of references.

6) References should be listed in alphabetical order at the end of the manuscript, taking the following form:

   Strong, L. (1981). Extensive damage to mummy H7386 by dermistid beetles. *Proceedings of the Bristol Naturalists' Society*, 40, (1980), 27-29.

   Mitchell, A.H.G. & Garson, M.S. (1981). *Mineral Deposits and Global Tectonic Settings*. London, Academic Press.

7) Line drawings should be in black ink on white paper or card, and all scales and labels should be inserted by the author(s). Drawings, tables etc. should not exceed 160 mm (6¼") in width and 235 mm (9¼") in depth. Photographs and drawings will be returned on request.

8) Brief captions to the illustrations should be gathered together to form an addendum to the manuscript.

9) A shortened version of the title suitable for page-headings should be supplied.

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Proceedings of the Bristol Naturalists' Society (1986), **46**: 51–59

AVON AND DISTRICT ENTOMOLOGICAL REPORT, 1986

Compiled by the Recorders of the Entomological Section:

R.S. Cropper S. Randolph
K.W. Miller R.W. Rowe
R.M. Payne G.W. Sorrell
K.H. Poole A.H. Weeks

Because the adverse weather resulted in much reduced insect activity, the volume of records received was very much less than in previous years in respect of all orders of insects. Also this year, the records of *Lepidoptera* received from BRERC were not so detailed, although they confirm the conclusions reached by BNS observers that the season was late and short and that population levels were down.

In addition to the recorders listed above, the Section is grateful to the following contributors:

R. Angles, P.J. Chadwick, E.A. Dean, S. Button, P. Crocker and M. Hayman.

1986 WEATHER SUMMARY (Compiled by A.H. WEEKS)

The weather in 1986 was generally poor for all kinds of insect life. The cold and overall wet winter was followed by an equally cold and wet spring. The summer was not bad, but only June had anything to commend it. There is no doubt that the weather in the six months March to August, covering the greater part of the season for *Lepidoptera*, was a disaster. For the second year in succession, high maxima in the summer were few, with 80 deg. F (26.6°C) being exceeded on only four days in June. The highest in July was 78.2°F (25.6°C) during a warm but rather cloudy spell in mid-month. In August 70°F (21.1°C) was exceeded on only three days and there was two with the maximum below 59°F (15.0°C). It was another summer with a high incidence of strong winds.

	MONTHLY DIFFERENCES			SEASONAL DIFFERENCES	
1986	Max. Temp.	% Rainfall	Approx. % sun	Max. Temp.	% Rainfall
January	- 0.3	123	95	Winter	
February	- 5.3	12	85	- 1.2	113
March	- 0.8	117	95		
April	- 2.8	113	87	Spring	
May	- 0.5	168	86	- 1.3	135
June	+ 1.6	70	95		
July	+ 0.1	78	90	Summer	
August	- 1.7	100	75	0.0	85
September	- 1.6	34	110		
October	+ 0.9	120	100	Autumn	
November	+ 1.6	144	110	+ 0.3	102
December	+ 1.9	143	110		

Table 1. Monthly and seasonal differences from normal of daytime maximum temperatures and rainfall percentages at Yatton, S. Avon.

BUTTERFLIES (*Lepidoptera*) by G.W. SORRELL and A.H. WEEKS

This was the poorest for many years with a slow start and early finish. Even common species like the Meadow Brown and Gatekeeper suffered dramatic population reductions, the former largely disappearing by mid-August. The worst affected species were the Blues with few sightings of all broods of the Holly and Common Blues and the Brown Argus. The Painted Lady was seen briefly in the second half of August and a few Red Admirals were seen for a slightly longer period. Good seasons were had by the Comma, Dark-green and Silver-washed Fritillaries. A newly discovered colony of the Marsh Fritillary was found in considerable numbers. The Large Tortoiseshell was not recorded. Large Whites were abundant in August but few caterpillars were found, possibly due to inclement weather for pairing.

First and last dates, with a note on peak periods, are included in the species summary with fuller information for rarer and scarcer species.

PIERIDAE

Pieris brassicae L. (Large White) 29 April to 17 October, abundant August.

P. rapae L. (Small White) 25 April to 14 October, frequent August.

P. napi L. (Green-veined White) 29 March to 26 September, frequent May and August.

Anthocaris cardamines L. (Orange Tip) 2 May to 23 June, fair numbers, most in late May.

Gonepterix rhamni L. (Brimstone) 3 April to 10 November, poor season, most mid-August.

Colias crocea Geofferoy (Clouded Yellow) Four singles, 16 August to 9 September at various sites.

Leptidea sinapis L. (Wood White) Three singles, 28 May to 2 July, Harry Stoke (BRERC).

NYMPHALIDAE

Inachis io L. (Peacock) 19 March to 20 September, fair season, most late August to early October.

Polygonia c-album L. (Comma) 29 March to 21 November, good numbers mid-August.

Limenitis camilla L. (White Admiral) 6 July to 14 August, good season at Lower Woods, Wetmoor.

Vanessa atalanta L. (Red Admiral) 23 June to 15 November, poor season, most late August.

V. cardui L. (Painted Lady) 29 May to 18 September, poor season, most late-August.

Argynnis paphia L. (Silver-washed Fritillary) 13 July to 28 August, good season at Lower Woods, Wetmoor; fair at Goblin Combe.

Mesoacidalia aglaja L. (Dark Green Fritillary) 6 July to 24 August, in reasonable numbers on Mendip from Crook Peak to Charterhouse.

Clossiana selene Schiff (Small Pearl-bordered Fritillary) 15 June to 17 July, poor year. Largest numbers Wetmoor; fair numbers in Goblin Combe.

Euphydryas aurinia Rott. (Marsh Fritillary) 8 to 19 June, good number seen at Wetmoor and Hollow Marsh (Hinton Blewitt).

SATYRIDAE

Melanargia galathea L. (Marbled White) 28 June to 24 August, mostly mid-July.

Maniola jurtina L. (Meadow Brown) 19 June to 27 September, most mid-July to early August but numbers down.

Aphantopus hyperanthus L. (Ringlet) 5 July to 24 August, most mid-July, numbers down.

Pyronia tithonus L. (Gatekeeper) 5 July to 16 September, most late July, numbers well down.

Coenonympha pamphilus L. (Small Heath) 27 June to 27 September, reasonable numbers, most late June to mid-July.

Pararge aegeria L. (Speckled Wood) 27 April to 4 November, widespread but numbers down.

Hipparchia semele L. (Grayling) 17 July to 18 August, reasonable numbers, mostly Goblin Combe early August. Also Dolebury Warren, Crook Peak, Uphill and Sand Point.

Lasiommata megera L. (Wall Brown) 5 June to 9 September, remaining scarce, small numbers at Goblin Combe, Dolebury Warren, Crook Peak, Uphill and Sand Point.

NEMEOBIIDAE

Hamearis lucina L. (Duke of Burgundy Fritillary), reasonable season, late May to early June, Midger Wood.

LYCAENIDAE

All species in this family were scarce this year.

Quercusia quercus L. (Purple Hairstreak) 20 July to 16 August, three records only.

Callophrys rubi L. (Green Hairstreak) 29 May to 30 June, four sightings only.

Strymonidia w-*album* Knoch (White Letter Hairstreak) 6 July and 8 August only.

Lycaena phlaeas L. (Small Copper) 12 May to 16 October, most in August.

Aricia agestis Schiff. (Brown Argus) 3 June to 21 September, very poor season, most early June, late summer brood 3 only.

Cupido minimus Fuessly (Small Blue) 5 to 17 June, 5 only.

Celastrina argiolus L. (Holly Blue) 19 May to 20 August, 8 only.

Lysandra coridon Poda (Chalkhill Blue) 26 July to 17 September, scarce, only in numbers at Draycott.

Polyommatus icarus Rott. (Common Blue) 7 June to 9 September, very poor season, most early June with late summer brood very scarce.

Thecla betulae L. (Brown Hairstreak) Very scarce, eggs found on blackthorn in March at its usual site at Walton, Hill, Street.

HESPERIDAE

Pyrgus malvae L. (Grizzled Skipper) 29 May to 15 June, poor season, seen early in small numbers.

Erynnis tages L. (Dingy Skipper) 29 May to 15 June, very scarce.

Thymelicus sylvestris Poda (Small Skipper) 4 July to 24 August, most late July and late August, numbers down.

Ochlodes venata Turati (Large Skipper) 18 June to 8 August, poor season, most early to mid-July.

MOTHS (*Lepidoptera*) by K.H. POOLE

1986 brought yet another poor season and relatively few records were received. The only migrants noted were the Silver-Y and, rather surprisingly, a number of Humming-bird Hawk Moths. Our thanks are due to the contributors below:

R. Angles, D. Aggaziz, C.S.H. Blathwayt, P. Crocker, M. Hayman, R.W. Rowe, A. Silcocks, G.W. Sorrell, and A.H. Weeks.

Names are in accordance with J.D. Bradley and D.S. Fletcher: *A Recorder's Logbook of British Butterflies and Moths*, 1979.

Sphinx ligustri L. (Privet Hawk Moth) Weston-super-Mare, 3 September. Larva in garden

Macroglossum stellatarum L. (Humming-bird Hawk Moth) Weston-super-Mare, 8 and 28 July; Sand Point, Weston-super-Mare 19 and 30 June (2), 1 July (4) (RA); Dolebury Warren, Churchill, 27 June, 24 July (2) (DA); Totterdown, Bristol, 11 July (PC).

Acronicta leporina L. (The Miller) Abbot's Leigh, Bristol, (2) 27 June (AS).

A. alni L. (Alder Dagger) Abbot's Leigh, Bristol, 14 and 27 June (2) (AS).

Tetheella fluctuosa Hb. (Satin Lutestring) Abbot's Leigh, Bristol, June (AS).

Noctua fimbriata Schreber (Broad-bordered Yellow Underwing) Stapleton, Bristol, 12 September (PC).

Laconobia suasa Denis & Schiff. (Dog's Tooth) Abbot's Leigh, Bristol, 23 June (AS).

Hadena confusa Hufnagel (Marbled Coronet) Weston-super-Mare, 2 June (CHSB).

Mythimna obsoleta Hb. (Obscure Wainscot) Abbot's Leigh, Bristol, 28 June (AS).

Lithophane leautieri Boisd. (Blair's Pinion) Weston-super-Mare, 7 October (CHSB).

Apamea furva Denis & Schiff. (The Confused) Weston-super-Mare, 7 October (CSHB).

Mesapamea secallina Hb. (Remm's Rustic or Lesser Common Rustic) Dolebury Bottom, Churchill, 20 to 22 August, a few at light (DA). A new record for the area.

Autographa bractea Denis & Schiff. (Gold Spangle) Abbot's Leigh, Bristol, 27 July (AS).

Lygephila pastinum Treitschke (The Blackneck) Charterhouse, 1 July (CSHB).

Chloroclysta siterata Hufnagel (Red-green Carpet) Weston-super-Mare, 12 October (CSHB).

Cepphis advenaria Hb. (Little Thorn) Weston-super-Mare, 18 June (CSHB); Abbot's Leigh, 16 June (2) (AS).

Lycia hirtaria Clerck (Brindled Beauty) Weston-super-Mare, 7 October (CSHB).

Ectropis extersaria Hb. (Brindled White Spot) Abbot's Leigh, Bristol, 24 and 26 June (AS).

Stigmella suberivora Stainton Cleeve, 31 January, several vacated mines on *Quercus ilex* (DA).

Ptycholomoides aeriferanus Herrich-Schäffer Dolebury Bottom, Churchill, 31 July (DA).

Pammene aurantiaria Hb. Dolebury Bottom, Churchill, 31 July (DA).

Caryocolum viscariella Stainton Dolebury Bottom, Churchill, 7 August (DA).

BEETLES (*Coleoptera*) by R.W. ROWE

In common with the experience of reporters of other orders, 1986 proved to be a most disappointing year from every point of view. The weather meant that opportunities to observe were less than usual and the direct result of this was that a very small number of records was received from only two reporters.

There is a great need for records to be submitted from the much neglected north, north eastern and eastern parts of our territory, not overlooking the fact that reports of the commoner species are as valuable as those of rarer insects and will help to give a more balanced picture.

Here follows a list of the more interesting records received; nomenclature follows that given in Kloet and Hincks, *A Check List of British Insects*, Vol. XI, Pt. 3, 2nd Ed. 1977. (Recorders: R.S. Cropper - RSC; R.W. Rowe - RWR).

Pogonocherus hispidus L. One in house, Burnham-on-Sea, 31 August (RSC).

Athous vittatus F. Two from gorse, Crook Peak, 26 May (RSC).

Amara aulica Pz. One beaten from a thistle head, Winterhead Hill, Shipham, 27 July (RWR).

Anthobium sorbi Gyll. One taken on hogweed, Winterhead Hill, Shipham, 27 July (RWR).

Geotrupes stercorarius L. One found dead on pavement in Temple Way, Bristol, 2 September (RWR).

Plateumaris sericea L. Several in marsh on plants, Windsor Hill, Shepton Mallet, 6 July (RSC).

HOVERFLIES (*Syrphidae*) by S. Randolph (by whom all records were made)

The sight of an *Eristalis tenax* sunning itself on a garden wall in Redland, Bristol on 3 January augured well for the season to come. In the event, a single Drone Fly brought out of hibernation very early did not make a summer!

Despite the poor weather, there were enough Hoverflies to make the season an interesting one. Particularly noticeable this year was the frequency with which *Scaeva pyrastri* was encountered. This is quite a large black hoverfly, strikingly marked, with a trio of paired white markings on its abdomen making it easily identifiable in the field. Although it is considered a resident, this year was obviously one of those in which its numbers were augmented by immigrants from the continent.

Forty two species were noted during the year and a selection of some of the more interesting follows. Several *Eristalis pertinax* on celandines, Brandon Hill Nature Reserve, Bristol, 1 April, heralded the start of the hoverfly season. An uncommon species, *Cheilosia grossa*, Cleaves Wood, nr Wellow was seen on a Section field trip on April 20th. This early season species normally peaks in late March to early April in the south.

Friary Wood, Sharpstone has proved in the past to hold interest for the entomologist and botanist (Randolph, 1985) and a visit to this woodland on May 18 found species, among which were *Neoascia podagrica*, a small common but easily overlooked species, *Rhingia campestris* and *Cheilosia antiqua*.

R. campestris, which was particularly plentiful, is a long "snouted" syrphid which spends its larval life feeding on cow dung. *C. antiqua* is a rather local woodland species whose larvae are known to feed in the stems of primrose (*Primula vulgaris*), often causing the plant to die as a result.

Several *Anasymia lineata* were seen around the margins of a small lake in the Kingston Seymour area. This lake had noticeable stands of reed-mace (*Typha*). The larvae of this fly have been reported as feeding on this decaying plant.

Epistrophe nitidicollis is an unusual hoverfly for this area and has been described as "fairly local" in the south and in the midlands. Woodland rides and coppice glades in May provide the best conditions (Stubbs & Falk, 1983). However, a single individual of this species was found in the entirely urban surroundings of a small garden in St. Andrew's, Bristol on June 18th.

A single specimen of the scarce species *Helophilus trioittatus* was seen near Cadbury Camp, Tickenham on June 22nd.

Volucella pellucens is a large and fairly common black hoverfly, the anterior part of its abdomen being conspicuously white and the wings having a prominent dark blotch in the middle. This species was found on an SSSI site at Vallis Vale nr Frome on June 28th. *V. pellucens* is unusual in laying its eggs in the nests of wasps. The larvae, after hatching, drop to the bottom of the nest where they scavenge on dead wasp larvae and adults. Gilbert (1985) gives further fascinating details of the larval and adult lives of this and other more common hoverflies.

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DAMSELFLIES & DRAGONFLIES (*Odonata*) by S. RANDOLPH

As with other orders there was a considerable reduction in records received reflecting a poor season for dragonflies. However, *Cordulia aenea* seems to have recovered from an extremely low population level in the last three seasons at Priddy.

Two exciting sightings were made during the year, both of nationally rare species. *Libellula fulva* was observed on the River Avon nr Saltford; no previous records are known for this area (v.c.6 and 34). The record has been accepted by the National Odonata Recording Scheme organiser.

The other exceptional record is of a single specimen of *Ceriagrion tenellum*, claimed to have been seen on Shapwick Heath. If substantiated, it will be the first record for this rare damselfly since 1974 for the area. Photographs or detailed descriptions will be needed to confirm the record.

ZYGOPTERA (Damselflies)

Platycnemis pennipes Pallas (White-legged Damselfly) One record only, from a new breeding site, River Boyd, Doynton, in small numbers in June (JH).

Pyrrhosoma nymphula Sulzer (Large Red Damselfly) 23 records. Several new breeding sites were found including two sites nr Kingston Seymour, 8 June (SR); Nailsea Railway Ponds, June (JH); six ponds in the Yate area, June to August (DT).

Ischnura elegans Van der Linden (Blue-tailed Damselfly) 23 records. Several new breeding sites including three nr Kingston Seymour, 8 June (SR); Hallen and Dyer's Common, 15 June (SR); four ponds, Yate area, June to August (DT); single female, colour form *R. rufescens*, Littleton Brick Pits, 27 July (RHP).

Enallagma cyathigerum Charpentier (Common Blue Damselfly) Nine records. New breeding sites include Ashcott Heath (JMB); Nailsea Ponds (JH); Leechpool nr Yate.

Coenagrion puella L. (Azure Damselfly) 24 records, all June and July. New breeding sites include Leechpool nr Yate; many hundreds along R. Kenn (SR); Nailsea ponds (JH); several ponds in Yate area (DT).

C. pulchellum Van der Linden (Variable Damselfly) Five records. No new breeding sites for this uncommon species. Chilton Moor is one of its strongholds with 40+ males noted on 2 June (JMB).

Ceriagrion tenellum (Small Red Damselfly) One record to be substantiated. Not recorded for the area since 1974. The sighting was of a single male at Shapwick Heath on 19 July (AB). This species is a weak flier rarely moving from its breeding site. If substantiated, there is a possibility of a colony surviving in this area.

Erythromma najas Hansemann (Emerald Damselfly) Four records. One new breeding site for this very local species, where small numbers were seen, Nailsea Railway Ponds, August (JH); single individual on cycle path nr Saltford (AH). This is at least 10 km from its nearest known breeding site at Chew Valley Lake.

Calopteryx virgo L. (Beautiful Demoiselle) Five records. One new breeding site, where it is common, Vallis Vale, nr Frome, 28 June (SR). A probable new breeding site has been found on the River Boyd at Doynton where three males were seen.

C. splendens Harris (Banded Demoiselle) Seven records. One new breeding site, River Boyd, small numbers of both sexes in June (JH). Possibly also a new site, Nailsea Railway Ponds - small stream, a few males, June (JH).

ANISOPTERA (Dragonflies)

Cordulegaster boltonii Donovan (Golden-ringed Dragonfly) One record, again for the same site on Blackdown, Mendip where it was seen in 1982 and 1985. One male (dead), 14 July (JMB).

Brachytron pratense Müller (Hairy Dragonfly) Seven records. One new breeding site where, for this species, unusually large numbers were seen, Nailsea Railway Ponds, ten males, June (JH). Also noted at Shapwick Heath, June (RHP, RSC) and Tealham, Chilton and Theale Moors (JMB).

Aeschna cyanea Müller (Southern Hawker) Thirteen records. Three new breeding sites. Garden pond, Stockwood, Bristol, where at least 50 adults emerged, June to August (JH). From records on several dates, breeding is now fairly certain in small numbers at Littleton Brick Pits, July and August (RHP). Also at Inglestone Common, three seen, 12 July (DT).

A. grandis Müller (Brown Hawker) Four records, two ponds nr Leechpool where it could be breeding, July and August (DT). One male seen on two occasions in a garden, Henleaze, Bristol, 19 July and 11 August (RHP).

A. juncea L. (Common Hawker) Two records, both from established breeding sites at Blackdown and Charterhouse, Mendip (JMB).

A. mixta Latreille (Scarce Hawker) Four records. Recorded for the first time at Littleton Brick Pits where one male among reeds by fish pond, 21 September (RHP). Noted at Westhay Heath, Westhay Moor and Catcott Heath (JMB).

Anax imperator Leach (Emperor Dragonfly) Five records. Two new breeding sites. One male and one ovipositing female, Nailsea Railway Ponds, August (JH). A new pool at Stockwood, Bristol, (AWT site) produced at least 57 adults after only one year, 20 June to 12 July (JH). Also noted at Leechpool, Yate, 17 August (DT).

Cordulia aenea L. (Downy Emerald) Two records. Our rarest dragonfly continues to maintain a breeding population at Priddy Mineries despite very low numbers in the last three years. 24 exuviae were found this year, with at least three on wing on 26 June (JMB, JH).

Orthetrum cancellatum L. (Black-tailed Skimmer) Seven records. One male noted at Nailsea Railway Ponds, August (JH). Now common at the 'New Scrapes' made by Avon Wildlife Trust at Herriott's Bridge, Chew Valley Lake, August (AM); Leechpool, Yate, 19 June (DT).

Libellula depressa L. (Broad-bodied Chaser) Eleven records. At least four new breeding sites including several at ponds in old waste tip, Hallen, Bristol, 11 June (SR). New pond at Stockwood, Bristol, produced an incredible 310+ after only one year, June and July (JH); Littleton Brick Pits, three males and one female, 13 July (RHP).

L. fulva Müller (Scarce Chaser) One record. An exciting sighting of this nationally rare species was made along the River Avon, immediately south of Bitton. A breeding population is known upstream nr Staverton, Wilts. The two males seen (one immature and the other fully mature and showing copulation marks on its abdomen) almost certainly dispersed downstream from the Wiltshire site. This record is from a Dorset recorder, 19 July (IC).

L. quadrimaculata L. (Four-spotted Chaser). Ten records. One new breeding site. Small numbers, Nailsea Railway Ponds, June (JH); probable new breeding sites at two ponds nr Leechpool, Yate, June to July (DT).

Sympetrum sanguineum Müller (Ruddy Darter) Four records, all from existing breeding sites: Westhay, Catcott Heath, Westhay Moor, Chilton Moor (JMB).

S. scoticum Leach (Black Darter) One record, Priddy Mineries (JMB).

S. striolatum Charpentier (Common Darter) Fourteen records. Two new breeding sites, Nailsea Ponds, a few teneral specimens, July (JH); Stockwood Pond (JH). Also noted at four new sites in North Avon in the Yate area but none confirmed as breeding. Very low numbers at Ashton Court, August to October (JH).

TRUE BUGS (*Hemiptera/Heteroptera*) by R.S. CROPPER

Another poor summer following another hard winter resulted in a disastrously low number of *Heteroptera*, in common with other insects. Amongst the more interesting records (which refer to single insects unless otherwise stated) were:-

Acanthosoma haemorrhoidale L. Nymph on hawthorn, Hunstrete, 21 September.

Piezodorus lituratus F. On gorse, Cook Peak, 26 May.

Deraeocoris lutescens Schilling On oak, Shapwick Heath, 20 September.

Blepharidopterus angulatus Fallèn Plentiful on alder, Shapwick Heath, 20 September.

Phytocoris longipennis Flor On oak, Shapwick Heath, 20 September.

Notonecta maculata F. In clear ditch, Dundon, 4 October.

Sigara fossarum Leach Abundant in pools, Chilton Moor, 17 September.

S. concinna Fieber Numerous in lagoon, Shapwick Heath, 28 September.

NATURE IN WALES - A REVIEW

From the painting of the Red Kite on the front cover to the symbolic dragon design on the back, the journal *Nature in Wales* is well designed, highly informative and excellently produced. It is published by the National Museum of Wales, edited until recently by Dr D.A. Bassett and from now onwards by Roy Perry. In its own words it is "a natural science journal for Wales and the Borderland".

The journal contains a wide variety of material presented in the form of substantial articles, notes, book reviews, news items and letters to the Editor. Much of its contents will be of interest to those far outside of Wales, but particularly to the Bristol Naturalists, who live so close to it. Coverage is perhaps best explained by comparing the contents of the first volume in the new series (1982) with that of the latest (1986/7).

In the 1982 volume, the editorial introduced the "new series" which took over from the initial series begun in 1955. The next article described an exhibition of 75 years of ornithology in Wales, followed by an inventory of National Nature Reserves in Wales. This has been expanded in later volumes, with detailed descriptions of some of the reserves. Other articles concerned the Welsh Plant Breeding Station at Aberystwyth, an outline of the Wildlife and Countryside Act, the problems of hydatidosis and the secret life of pauropods - quite a varied diet! Various notes were followed by a review of the problems and benefits of designing a tidal power barrage in the Severn estuary, based on the findings of the Bondi Committee - a little dated now, but still informative. Field notes, book reviews and letters to the Editor came next, finishing with addresses of scientific, educational and conservation bodies in Wales.

The latest volume has continued the format of the first and includes articles on the history of Elms in Wales, the effect of agricultural improvement on upland breeding birds, a systematic survey of the Cwm Idwal National Nature Reserve and an historical account of botanical exploration in Pembrokeshire. The "notes" include geological, entomological, botanical and ornithological entries and are followed by an extremely interesting account of natural history "happenings" in Wales from 1955 to 1985. News items discuss such points as the proposed marine nature reserve at Skomer.

From the above, you will see that in a single page review it is impossible to do justice to the coverage of the journal! Volume 1 Part 1 (1982) contained 79 pages, including more than 40 photographs and 20 line drawings. Volume 5 (which includes Parts 1 and 2) contains 120 pages with 10 photographs, 20 line drawings and 10 tables.

Nature in Wales is normally issued twice a year (October and March) and is obtainable from the National Museum of Wales, Cathays Park, Cardiff CF1 3NP. At the remarkably low price of about £1.50 per issue, it is outstanding value for money for any naturalist.

COLIN LITTLE

Proceedings of the Bristol Naturalists' Society (1986), **46**: 61–71

BRISTOL BOTANY IN 1986

by A.J. WILLIS

(Department of Botany, University of Sheffield)

Overall 1986 was a year of below average temperature, above average rainfall and about average hours of sunshine. Air temperatures were 0.8°C below the yearly mean, April, August and September being more than 2°C below the norm, and February being exceptionally cold, 5.1°C below average and with 24 ground frosts. Although *Helleborus foetidus* had well developed buds in early January, the low temperatures and snow in February delayed the growth of vernal species, for example snowdrops being at their best over a month late at the end of March in Stoke Lane Valley, Edford. Plants were slow in catching up, *Gagea lutea* failing to flower in at least two known sites and *Arabis stricta* being still in bud in the Avon Gorge in early April when it is often flowering (RSC). February and September were dry months, but rainfall during the summer was fairly normal and for the year totalled 959.0 mm, 110% of the average (all meteorological records relate to Long Ashton Research Station). The weather may have favoured *Aster linosyris* at Uphill which is increasing now (RSC) after a poor flowering performance in the relatively dry summers of 1983 and 1984.

Many interesting plant records were made in 1986, including several of nationally rare or uncommon plants found new to the Bristol area. Of particular note is the Horsetail *Equisetum ramosissimum*, recorded on sandy ground at Weston-super-Mare. This is a southern European species, first collected in Britain in 1947 in S. Lincoln. The occurrence of *Spergularia rupicola* in a natural habitat (rocks) at Weston-super-Mare is also noteworthy. The rare *Filago pyramidata* is recorded on limestone grassland near Axbridge and the orchid *Dactylorhiza traunsteineri* on wet ground at Winscombe. The record of the hybrid grass *Alopecurus* x *brachystylus* at West Harptree gives a second locality for North Somerset. The alien *Gaudinia fragilis*, already known for Bristol, is reported from Winscombe. Studies of a long-known but unnamed *Sorbus* in the Avon Gorge and elsewhere by PJMN have elucidated the distribution and performance in the Bristol area of this taxon which is now reported under *Sorbus devoniensis* 'Theophrasta'. A substantial number of less common bryophytes are recorded from Mendip, pride of place going to *Colura calyptrifolia*; this rare liverwort of western distribution in Britain is new to v.c.6.

As repeatedly found, observations testify to the long persistence of plants in particular localities, even if they have been feared lost, with no specimens seen for a number of years. An attractive colour form of *Viola hirta* thought lost as a result of ploughing on Tickenham Hill, S, is now known to persist, albeit in small quantity. Similarly *Sedum telephium* recorded in Babington's *Flora Bathoniensis* (1834) for Wick Rocks, G, and not seen there since 1955, was known to be represented by at least one plant in 1986 (PJMN). Ploughing at Publow Hill, S, in 1977 appeared to destroy the population of *Astragalus glycyphyllos* but a plant was found at the site in 1986 (RSC). *Doronicum pardalianches*, known last century in a wood near Conkwell, S, still persists in Warleigh Wood as a large patch (RDR). *Petroselinum crispum* remains abundant in Redcliffe Parade, Bristol (IFG). The reappearance of *Stratiotes aloides* in the particular ditches in South Moor, Glastonbury, where it was known until the drought of 1976 was a welcome sight in 1986 (Mrs M. Collins). *Papaver atlanticum* is still present in quantity in a lane at Fishponds, Bristol, where known since 1963 (ALG).

An interesting find somewhat north of our area is *Cardaria chalepensis* (L.) Handel-Mazzetti. This species is well established on waste ground around the docks at Sharpness, and also at the top of the salt marsh there (T.C.G. Rich, CK & MARK). The fully developed ripe fruit is ovate with a cuneate to broadly rounded base, differing from the cordate to broadly triangular fruit with a truncate to emarginate base of *C. draba*.

The *Supplement to the Flora of Gloucestershire* by Mrs S.C. Holland (Executive Editor), Miss H.M. Caddick, Mrs D.S. Dudley-Smith and (up to 1982) Miss K.E. Ludbrook was issued (Grenfell Publications, Bristol) early in 1986. This fills many gaps in the well-known *Flora of Gloucestershire* (1948) by H.J. Riddelsdell, G.W. Hedley and W.R. Price, reflecting in part the present-day more exhaustive and systematic recording based on the grid system. Clearly many changes in plant distribution, well documented here, have occurred in recent decades; unfortunately, as elsewhere in Britain, a substantial number of rare and interesting plants have been reduced or even become extinct. *Herminium monorchis*, the distribution of which is shown in a 'dot' map, has, for example, been lost from a number of sites; another example is *Parnassia palustris*, which is known to be reduced in occurrence. Although gains seemingly balance losses in the flora, some taxa listed as new to the area are the result of specialist study of 'difficult' taxa and of hybrids. As the *Supplement* covers the Administrative County of Gloucestershire much of Botanical District 5 (now in Avon) is excluded, so no update is provided here for the floristically rich area of v.c.34 adjoining Bristol. The colour plates are an outstanding feature, being of excellent quality, while the frontispiece and dust cover show the handsome Pasque Flower painted by Gerald Atkinson for the 1948 *Flora*.

Names of contributors associated with several records, or with the determination of specimens, are abbreviated thus:

RSC	R.S. Cropper	PJMN	P.J.M. Nethercott
RF	Lady Rosemary FitzGerald	AN	A. Newton
IFG	Miss I.F. Gravestock	RMP	R.M. Payne
ALG	A.L. Grenfell	RDR	R.D. Randall
RAJ	R.A. Janes	RGBR	Capt. R.G.B. Roe, RN
CK	Mrs C. Kitchen	PR	P. Rooney
MARK	M.A.R. Kitchen	MAS	Mrs M.A. Silcocks
PM	P. Martin	HET	Mrs H.E. Titchen
EJMcD	Mrs E.J. McDonnell		

G: Gloucestershire S: Somerset

For details of the area covered by this Report, see 'Bristol Botany in 1978', p.35.

Asplenium adiantum-nigrum L. One plant in moss and litter in cutting through Oolite of old railway, Lyncombe Vale, Bath, S, H.G. Ward.

Athyrium filix-femina (L.) Roth Woods surrounding Tortworth Lake, G, CK and MARK. Rather uncommon in this vicinity.

Polystichum aculeatum (L.) Roth Two plants with *P. setiferum*, on side of lane, Newton, near Thornbury, G, CK and MARK.

Helleborus viridis L. Abundant along ride, Cleaves Wood, nr Hinton Charterhouse, S, and flowering in native woodland, St. Catherine's, S, where long known, RSC.

Ranunculus lingua L. A few plants in rhyne, Clapton Moor, S, MAS.

R. ficaria L. var. *incumbens* F. Schultz In good quantity on streambanks, roadside, Kington, G, CK and MARK.

Aquilegia vulgaris L. A few plants, with purple petals, on rough limestone hillside, Tickenham Hill, S, PJMN.

Nuphar lutea (L.) Sm. Gall Pond, Tortworth, and persistent in Tortworth Park Lake, G, CK and MARK.

Lepidium latifolium L. In small quantity on road verge, Oldbury-on-Severn, G, CK and MARK. This is a southern extension of its Severnside locality.

Arabidopsis thaliana (L.) Heynh. Flowering and fruiting abundantly in railway sidings, Radstock, S, RSC.

Viola hirta L. One surviving plant of 'a good colony of White-flowered forms' reported as lost through ploughing up (see 'Bristol Botany in 1962', p.301), Tickenham Hill, S, PJMN. A careful search of the upper slopes of Tickenham Hill made by PJMN in April 1987 revealed five tiny colonies of the strikingly beautiful colour form, var. *lactiflora* Reichb. (see White *Flora of Bristol*, 1912, p.174), and two plants with almost pure white flowers. The normal blue *V. hirta* was scarce, and there were only a very few small plants of this on the lower slopes.

Hypericum androsaemum L. In lane and on roadside, Stoke Bishop, Bristol, G, IFG.

H. maculatum Crantz ssp. *obtusiusculum* (Tourlet) Hayek A small stand by lane, Crossways, nr Thornbury, G, CK and MARK. Many fine patches persistent along woodland ride and elsewhere in the vicinity in small quantity, Stock Hill, Chewton Mendip, S, RSC.

Myosoton aquaticum (L.) Moench A small colony on the right bank of the River Boyd, Wick Rocks, G, PJMN.

Spergularia rupicola Lebel ex Le Jolis Many plants on rocks, and also walls and neglected flower border, Weston-super-Mare, S, RSC, conf. Dr J.A. Ratter. Previously recorded (1963) in a lawn but this is the first v.c.6 record for a natural habitat.

Scleranthus annuus L. In quantity on dry, stony slope of the Bury Hill Iron Age Camp, Moorend, Winterbourne Down, G, ALG. Close to site where *Spergularia rubra* appeared two years previously after a fire.

Chenopodium polyspermum L. Two flowering patches, Westhay Heath, S, RSC.

Atriplex laciniata L. Along strand-line as well as *Salsola kali* L., at Sand Bay, S, RSC (also MAS). These two species appear to be recent colonists on this beach. Also a single flowering specimen of *Lavatera arborea* L. on beach to the north, RSC.

Anthyllis vulneraria L. Windsor Hill, Shepton Mallet, S, RSC. Also a fine patch of *Vicia sylvatica* L. nearby on old railway line, RSC.

Lotus tenuis Waldst. & Kit ex Willd. Small patch, seawall, nr Oldbury Nuclear Power Station, G, and abundant on old seawall near Berkeley Nuclear Power

Station, G, CK and MARK.

Vicia bithynica (L.) L. Under hedgerow of meadow, nr Winford, S, RAJ.

Rubus cardiophyllus Muell. & Lefèv. Edge of wood, on Midford sands, Newton St. Loe, S, RDR.

R. wirralensis A. Newton Shrubby pasture near Stanton Wick, S, and in open area of Fox's Wood, Brislington, S, RDR, det. AN. Previously recorded from the latter locality (see White *Flora of Bristol*, 1912, p.279, under *R. mucronatus* Bloxam).

R. raduloides (Rogers) Sudre Scrubby pasture near Stanton Wick, S; abundant from Fox's Wood, Brislington to Hanham Ferry and in copse by the Humpy Tumps, S, RDR, det. AN.

R. diversus W.C.R. Wats. Abundant from Fox's Wood, Brislington to Hanham Ferry, S, RDR, conf. AN. Records in White *Flora of Bristol*, 1912, pp.286-287, given under *R. Kaltenbachii* Metsch. refer to this taxon.

R. hylocharis W.C.R. Wats. A few plants, Lord's Wood, Pensford; large patch in wood, Woollard, S; frequent in Fox's Wood, Brislington, S, RDR, conf. AN.

Alchemilla filicaulis Buser ssp. *vestita* (Buser) M.E. Bradshaw Asham Wood, nr Frome, S, RSC. Also in pasture beside Friary Wood, Hinton Charterhouse, S, J. Maxwell.

Rosa obtusifolia Desv. In 1985, Compton Dando, S, M.W.J. Paskin, conf. G.G. Graham.

Crataegus laevigata (Poir.) DC. A single tree in hedge of field, and also *Pyrus pyraster* Burgsd. (three large trees), Lower Stone, G, CK and MARK. In 1985, roadside hedge, Winscombe, S, J.G. Keylock and RMP.

Sorbus devoniensis E.F. Warburg *'Theophrasta'* Since 1957 trees of two taxa of *S. latifolia* s.l. have been known in the Avon Gorge by PJMN. One is *S. latifolia* (Lam.) Pers. s.s., the Service Tree of Fontainebleau (see 'Bristol Botany in 1978', p.38); the other resembles *S. devoniensis* Warb. but has rather coarser leaves and large orange fruit. The latter form is described and illustrated in *Dendroflora* 3 (1966), pp.60-72, and *Dendroflora* 4 (1967), pp.51-60, by Dr K.J.W. Hensen of Wageningen, The Netherlands. Although previously briefly described by Dr E.F. Warburg (Clapham, Tutin & Warburg *Flora of the British Isles* (1952), p.555) it was not then named.

One large tree is in Leigh Woods, and several other small trees and saplings are on both sides of the Avon Gorge, G and S; a small number of trees, from large to saplings, are present in Sneyd Park, G, of which a few of the largest have been felled in the course of residential development; there are two large trees and a sapling on Durdham Down, G; a sapling is known on Tickenham Hill, S; all records PJMN.

This *Sorbus* is uniform and reproduces fairly readily; its origin is uncertain, but the taxon has most likely arisen in the British Isles, quite probably in cultivation, perhaps in Scotland, and has derived from *S. devoniensis*. The population in the Bristol area is considered likely (PJMN) to have arisen from planted trees in Sneyd Park.

S. torminalis (L.) Crantz   Small numbers of trees, some isolated single specimens, but including a huge old tree in a remnant of old woodland and one very fine tree, in and near Falfield, G; also single specimens at Whitfield, Berkeley Heath and Lower Stone, G, CK and MARK. Several of the single trees in hedges have been severely cut back.

Sedum telephium L.   On wall-top, some distance from houses, and probably native, West Harptree, S, RMP.

Epilobium lanceolatum Sebastiani & Mauri   Several plants, shady hedgebank, Bishop Sutton, S, RMP.

Myriophyllum verticillatum L.   Flowering abundantly in pool, Chilton Moor, S, RSC. Also, nearby, *Lysimachia vulgaris* L., *Juncus bulbosus* L. and *Isolepis setacea* (L.) R.Br.

Hydrocotyle vulgaris L.   A small patch with *Sphagnum* in boggy area, Beacon Hill, nr Oakhill, S, RSC.

Petroselinum segetum (L.) Koch   A few plants at base of seawall, nr Oldbury Nuclear Power Station, G, CK and MARK, where first noticed in 1985. The site for this plant at Severnside Plantation was destroyed in 1984-85 during the reconstruction of the seawall.

Oenanthe pimpinelloides L.   Abundant in paddock, St. Werburgh's, Bristol, G, ALG.

Euphorbia platyphyllos L.   A single plant in garden, Winterbourne Down, G, ALG. Two fine plants on recently disturbed peat, Chilton Moor, S, RSC.

Polygonum amphibium L.   Terrestrial form, adjoining pond, Stockwood, Bristol, G, IFG.

Rumex pulcher L.   Several flowering plants in rough grassy area, Observatory Hill, Clifton, Bristol, G, RSC.

R. maritimus L.   A few fine patches on heaps of peat, Chilton Moor, S, RSC. Also *Chenopodium rubrum* L. and *C. polyspermum* L., the latter plentiful on piles of peat.

Salix triandra L.   Several trees on wood margin, Duckhole, nr Thornbury, G, and a single tree in hedge, Maniards Green, nr Hill, G, CK and MARK.

S. x *mollissima* Hoffm. ex Elwert (*S. triandra* x *viminalis*)   In 1985, the var. *hippophaifolia* (Thuill.) Wimm., Nye Farm, Winscombe, S, RF and EJMcD. In 1985 var. *undulata* (Ehrh.) Wimm., Tickenham Moor, S, PR, det. R.D. Meikle.

Primula veris L. x *vulgaris* Hudson   With both parents, on bank at Henley Hill, Wookey, S, RSC. Also, with *P. vulgaris* but no *P. veris* nearby, in wood, Stoke Lane Valley, Edford, S, RSC.

Hottonia palustris L.   Plentiful in rhyne, Knowle Moor, nr Bleadney, S, RSC.

Cynoglossum officinale L.   In 1985, Hanging Hill Wood, Long Ashton, S, PR *et al*. Persistent at Brean, S, RSC.

Symphytum tuberosum L. Sandford Hill, Winscombe, S, Miss A.P. Pockson and Miss S. Tucker, conf. RGBR.

Myosotis ramosissima Rochel Knowle Hill, West Compton, S, RSC.

Misopates orontium (L.) Rafin. Known for fifteen years as garden weed, Winterbourne Down, G, ALG. Now a very uncommon arable weed in the area.

Linaria repens (L.) Mill. In 1985, by railway track, Backwell, S, PR. Also on wall, Hunstrete, S, RDR, and on old grave, Haycombe Cemetery, Bath, S, C. Gage.

Lathraea squamaria L. Knowle Wood, Churchill, S; also Churchill Batch and Mendip Lodge Wood, S, RSC. This plant has been known with certainty on the Gloucestershire side of the Avon Gorge since 1961 (see 'Bristol Botany' articles for 1971 and 1972), but was probably present for very many years previously. In 'Miss Ann Green of Clifton', an historical novel by Ethel W. Baker, published (Richards Press, Bristol) in 1936 (2nd edition by Reece Winstone, 1974), Toothwort is mentioned as one of a number collected by the heroine in about 1814 on Clifton Down and in the vicinity of St. Vincent's Rocks. Other plants noted included Autumn Squill, Columbine, Bloody Cranesbill and Rock Cress (IFG). It is of interest that all of these plants, as well as *L. squamaria*, were listed on a slip of paper in a Herbarium book of Dr Arthur Broughton of 1779 (see article by AJW and D. Gledhill in these *Proceedings* for 1970, pp. 54-55) for St. Vincent's Rocks.

Utricularia vulgaris L. Weston-in-Gordano Moor, S, MAS *et al.* Also *Hyocyamus niger* L.

Thymus pulegioides L. Several plants in flower on rocky banks, Litton Reservoir, S, RSC.

Stachys arvensis (L.) L. A few plants in fallow field, Milbury Heath, G, and a single plant by road, Bibstone, G, CK and MARK.

S. sylvatica L. forma *viridiflora* Fischer-Ooster Single plants, Wotton-under-Edge and by hedge, Oldbury-on-Severn, G, CK and MARK.

Lamium hybridum Vill. Occasional garden weed, Winterbourne Down, G, ALG. A small flowering patch in grass, Brean Down, S, RSC, conf. RGBR. Also, in 1985, Winscombe and Churchill, S, RF and EJMcD.

Scutellaria galericulata L. With *Bidens tripartita* L., near seawall above salt marsh, Portishead, S, HET.

Plantago coronopus L. var. *sabrinae* Baker fil. & Cardew Neglected flowerbed near sea front, Weston-super-Mare, S, RGBR.

Asperula cynanchica L. Hillside below Cadbury Camp, Tickenham, S, E.S. Smith.

Sambucus ebulus L. Persistent on roadside at edge of playing field on site of former open-cast coal mine, Speedwell, Bristol, G, ALG. First noted in 1984 but obviously an introduction of much longer standing.

Valerianella carinata Loisel. Uphill, S, RSC.

Dipsacus pilosus L. Abundant in valley bottom, Tortworth, G, CK and MARK. Also by the Newton Brook, Pennyquick, Bath, S, H.G. Ward.

Senecio viscosus L. Plentiful, adjoining car park, Berkeley Nuclear Power Station, G, CK and MARK.

Filago pyramidata L. In 1985, limestone grassland, Fry's Hill, Axbridge, S, EJMcD, det C. Jeffreys.

Achillea ptarmica L. In roadside ditch, Chew Stoke, S, RMP.

Cirsium eriophorum (L.) Scop. Rare in one quarried area, Wick Rocks, G, PJMN.

Centaurea cyanus L. With *Galeopsis tetrahit* L. and *Gnaphalium uliginosum* L. on earth dam of new reservoir, Woollard, S, RDR.

Serratula tinctoria L. Small colony, near old pits in field, near Michael Wood, nr Damery, G, CK and MARK. Also Ashcott Heath, S, RSC.

Cichorium intybus L. Sheperdine, G, CK and MARK, from where recorded by J.W. White (Riddelsdell *et al. Flora of Gloucestershire*, 1948).

Lactuca serriola L. By track by old mill, Winford Brook, S, RAJ.

L. virosa L. Two plants in scrub, Worrall's Lane, Winterbourne Down, G; under wall by roadside, Stapleton, Bristol, G; on ballast, Temple Meads Station, Bristol, G, and at Bedminster, Bristol, S, ALG. Known from a very few localities in the Bristol area for many years this species now appears to be rapidly extending its range.

Baldellia ranunculoides (L.) Parl. A few plants in rhyne, Chilton Moor, S, RSC.

Potamogeton coloratus Hornem. One small patch in rhyne, Weston Moor, S, MAS. Known in this moor previously (see 'Bristol Botany in 1974', p.17).

Groenlandia densa (L.) Fourr. Two small patches in the Middle Yeo, Clevedon Moor, S, MAS. Also *Ranunculus circinatus* Sibth.

Zannichellia palustris L. Abundant and fruiting in rhyne near new seawall, Hill Pill, G, CK and MARK.

Polygonatum multiflorum (L.) All. With *Paris quadrifolia* L. and *Vicia sylvatica* L., in recently coppiced Dallimore's Copse, nr Litton, S, RAJ.

Paris quadrifolia L. In several places in woodland, Stoke Lane Valley, Edford, S, RSC. Also in Warleigh Wood, nr Conkwell, S, RDR.

Juncus ambiguus Guss. (*J. ranarius* Song. & Perr.) Plentiful on muddy sand on margins of salt marsh, Berrow, S, RSC. Also by brackish pools, Stert Island, S, RSC.

Narcissus pseudonarcissus L. A few plants, Cleaves Wood, nr Hinton Charterhouse, S, and on Hedgebank, Lyncombe Hill, nr Sandford, S, RSC.

Ophrys apifera Hudson One plant resembling var. *trollii* (Hegetschw.) Druce

Max Meadows, Winscombe, S, RSC. Also, in wet area in this vicinity, *Anagallis tenella* (L.) L., *Triglochin palustris* L. and *Equisetum fluviatile* L.

Dactylorhiza traunsteineri (Sauter) Soó Damp meadow, Winscombe, S, S. Hedley, det. J.J. Wood.

Anacamptis pyramidalis (L.) L.C.M. Richard A plant with white flowers, near church, Berrow, S, RSC.

Lemna polyrhiza L. Abundant in rhyne, Duckhole, north of Thornbury, G, CK and MARK, but now very rare in v.c.34.

Eriophorum angustifolium Honckeny A good fruiting patch, wet meadow, Walton Moor, S, RSC.

Eleogiton fluitans (L.) Link Persistent in peat cuttings, Shapwick Heath, S, RSC.

Carex binervis Sm. With *Luzula multiflora* (Retz.) Lej., East Harptree Wood, S, RAJ.

C. pseudocyperus L. In small quantity, Tortworth Lake, G, CK and MARK, where long known.

C. rostrata Stokes Fruiting well in rhyne, Edington Heath, S, RSC.

C. strigosa Hudson Several fruiting plants in wet, shady spot in woodland, Englishcombe, S, RSC. One plant by roadside, Woolley, nr Bath, S, RDR.

C. acuta L. In 1985, by drove, Winscombe, S, RF and EJMcD.

C. disticha Hudson Abumdant on margins of Chew Valley Lake, S, RMP. Also Westhay Moor, S, RSC.

Lolium x *hybridum* Hausskn. On newly contoured and seeded area, landward of seawall, Severn House Farm, G, CK and MARK (conf. A. Leslie, pers. comm. R. Sherlock).

Puccinellia distans (Jacq.) Parl. Abundant along seawall between Oldbury Pill and Cowhill Pill, G, and also along newly graded seawall, Hills Flats, G, CK and MARK. With *Apium graveolens* L., Pill, S, RSC.

Leymus arenarius (L.) Hochst. A small patch on beach, Sand Bay, Kewstoke, S, RSC. This appears to be a recent arrival.

Arrhenatherum elatius (L.) Beauv. ex J. & C. Presl ssp. *bulbosum* (Willd.) Schübler & Martens On manure heap, Congresbury, S, Miss V.E. Graham.

Calamagrostis epigejos (L.) Roth A large colony, steep hillside, West Harptree, S, RAJ, det. RMP.

Alopecurus x *brachystylus* Peterm. (*A. geniculatus* L. x *pratensis* L.) With both parents in wet waste ground, West Harptree, S, RMP, conf. T.A. Cope. This hybrid was first recorded for the district at Tickenham Moor in 1942 (see 'Bristol Botany in 1942', p.364). The present record is the second for v.c.6.

ALIENS. *Equisetum ramosissimum* Desf. Sandy ground, Weston-super-Mare, S, I. Green, det. A.C. Jermy (also reported by ALG). This Horsetail is new to v.c.6; the present record is only the second locality known in the British Isles for this very rare species, first reported from S. Lincoln. At Weston-super-Mare it extends for about 100 yards, growing quite thickly about a foot tall, on a low sandy bank in an enclosed area of the dune system (RGBR). While the plant may have a long history in this site, it could have been introduced with planted shrubs or trees and, like the Lincoln population, which is thought introduced with soil, is considered an alien.

Azolla filiculoides Lam. Common Moor, Glastonbury, S, Mrs M. Collins. This is the furthest inland record for the area.

Corydalis bulbosa (L.) DC. Well naturalized and plentiful in woodland, Ston Easton, S, Mrs K. Targett, det. RMP. This garden escape was first known in a wood in this locality in 1922 (see 'Bristol Botany in 1922', p.267).

Coronopus didymus (L.) Sm. Abundant in field, Thornbury, G, CK and MARK.

Rorippa austriaca (Crantz) Bess. In 1984, waste ground, Whitchurch, S, R.D. Martin.

Amaranthus deflexus L. With *Digitaria sanguinalis* (L.) Scop. and *Panicum dichotomiflorum* Michx., among other aliens, Cumberland Basin, Bristol, G, ALG.

Malva verticillata L. In 1985, disused railway track, Kenn, S, J. Ounsted *et al.*

Impatiens capensis Meerb. A single plant, on pebbles by seawall, Portishead, S, HET.

Vicia villosa Roth ssp. *villosa* With *V. villosa* ssp. *varia* (Host) Corb. (*V. dasycarpa* Ten.) on roundabout, Lawrence Hill, Bristol, G, ALG, in 1985. The latter also on roadside, St. Phillip's, Bristol, G, ALG, in 1985.

Lathyrus grandiflorus Sibth. & Sm. Thoroughly naturalized in hedge on site of former cottage, West Harptree, S, RMP.

Duchesnea indica (Andr.) Focke Abundant and thoroughly naturalized in churchyard, Berkeley, G, CK and MARK, where first noticed in 1984.

Prunus cerasifera Ehrh. Lane, Stoke Bishop, G, IFG.

Cotoneaster bullatus Bois. Old railway track, Clutton, S, RMP, det. ALG.

Bupleurum fontanesii Guss. ex Caruel One large plant on mound of chippings, Falfield, G, CK and MARK, conf. ALG. Very little seed was set.

Reynoutria japonica Houtt. x *sachalinensis* (Friedrich Schmidt Petrop.) Nakai With 2n=66, abundant at border of rhyne, Shirehampton - Avonmouth, G, IFG, det. J.P. Bailey.

Rumex scutatus L. In garden, probably from a former planting, Winterbourne Down, G, ALG.

Juglans regia L. Two large trees in hedge, Hill, G, CK and MARK.

Pentaglottis sempervirens (L.) Tausch. Small colony by roadside, Crossways, nr Thornbury, G, CK and MARK.

Calystegia sepium (L.) R.Br. ssp. *pulchra* (Brummitt & Heywood) Tutin A good patch at edge of salt marsh, Berrow, S, RSC.

Physalis peruviana L. A single plant with one specimen of *Scorpiurus muricatus* L. represented the sole interest at the Avonmouth Sewage Works, G, ALG, in 1986, in sharp contrast to the number of plants of *P. peruviana* in 1985.

Capsicum annuum L. A single plant on Northwick Tip, G, ALG and R.M. Burton. Also present were *Coriandrum sativum* L. and *Carthamus tinctorius* L.

Melissa officinalis L. A single large clump, wall, Berkeley, G, CK and MARK, where known for over ten years, ALG.

Campanula poscharskyana Degen. This garden escape at roadside, Easton, S, RGBR.

Iva xanthifolia Nutt. A single plant on road verge, Avonmouth, G, ALG. Also in Avonmouth Docks, where other notable plants included *Agrostis gigantea* Roth, *Amaranthus hybridus* L., *Anethum graveolens* L., *Avena ludoviciana* Dur., *A. sterilis* L., *Crepis tectorum* L., *Kochia scoparia* (L.) Schrader, *Lappula squarrosa* (Retz.) Dumort., *Melilotus sulcata* Desf., *Phalaris paradoxa* L. var. *praemorsa* Coss. & Dur., *Poa palustris* L., *Rumex triangulivalvis* (Danser) Rech. fil., *Setaria faberi* Herrm., *Sisymbrium loeselii* L. and *Torilis nodosa* (L.) Gaertn., ALG.

Senecio fluviatilis Wallr. In old pasture, by Salter's Brook, south of Pensford, S, RAJ.

Inula helenium L. Small colonies in field margins at three sites, Compton Martin, S, Miss A.P. Pockson.

Silybum marianum (L.) Gaertn. In 1985, Stowey, S, RMP.

Juncus tenuis Willd. A single clump amongst large stone blocks recently laid to stop erosion, Aust Cliffs, G, CK and MARK.

Allium carinatum L. Roadside, Stoke Bishop, Bristol, G, IFG.

Bromus madritensis L. Many plants at base of wall on roadside, North Weston, S; also a single plant on hard core on Walton Moor, S, MAS. The variety with hairy spikelets was reported from waste ground in Gordano in 1985.

B. willdenowii Kunth Waste ground, Bath, S, D.E. Green, conf. RMP.

Hordeum jubatum L. Thinly spread over a long stretch of the rebuilt seawall from near Severn House Farm to Hill Pill, G, CK and MARK.

Gaudinia fragilis (L.) Beauv. Meadow, Winscombe, S, J. Woodman.

BRYOPHYTES. *Riccia cavernosa* Hoffm. On sandy soil, Denny Island and nearby in bay nr Woodford Lodge, Chew Valley Lake, S, PM. This rare liverwort was formerly known in the Berrow dunes, but in recent years has been found at Litton Reservoir and Blagdon Lake.

Scapania undulata (L.) Dum. On steep bankside of stream, Hunstrete Plantation, nr Chelwood, S, PM.

Cephaloziella stellulifera (Tayl.) Schiffn. On rather bare soil under pine trees, East Harptree Plantation, S, PM, det. Mrs J.A. Paton.

Colura calyptrifolia (Hook.) Dum. On tree trunk in wet area, East Harptree Plantation, S, PM. This is a new v.c.6 record for this rare liverwort of Western Britain.

Archidium alternifolium (Hedw.) Mitt. Woodland path, Lord's Wood, Pensford, S, PM.

Tortula ruralis (Hedw.) Gaertn. ssp. *ruraliformis* (Besch.) Dix. Adjoining path near old buildings, Pensford Mine, S, PM. A locality well inland for this moss usually found on coastal dunes.

T. marginata (Br. Eur.) Spruce Rock in reedbed, Denny Island, Chew Valley Lake, S, PM.

T. latifolia Bruch ex Hartm. Path in churchyard, Compton Dando, S, PM.

Barbula reflexa (Brid.) Brid. Stone bridge over stream, Lord's Wood, Pensford, S, PM.

Hygrohypnum luridum (Hedw.) Jenn. On rocks in stream-bed, Tynemoor Wood, nr Bishop Sutton, S, PM.

Calliergon stramineum (Brid.) Kindb. In wet grassy area around pond, East Harptree Plantation, S, PM.

C. cordifolium (Hedw.) Kindb. Eaker Hill Woods, nr Chewton Mendip, S, PM. Uncommon in marshy woodland but frequent on the peat moors.

Isothecium striatulum (Spruce) Kindb. On rock in Bithams Wood, nr Chew Magna, S, PM.

I thank everyone who has supplied records and helped with these, especially Mr P.J.M. Nethercott, Captain R.G.B. Roe, Mr A.L. Grenfell and Mrs J. Appleyard. I am indebted to Long Ashton Research Station for meteorological records.

EDITOR'S REMINDER

The next issue of *Proceedings* in 1988 will be the first of the new theme issues and the papers for this volume will all be concerned with the topic "The Avon Gorge".

Several papers have already been offered and accepted, but there is room for more, with a target closing date of the end of February 1988.

If you have material on the natural history of the Avon Gorge which you think might be of interest to members of the Society, please consider writing it up. I would be very happy to talk to you about it on 43123 (evenings) or 303030 ext. 3848 during the day.

A.E. FREY, Hon. Editor

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D. Hamilton, B.A., M.Sc., Ph.D.
J.F.W. McOmie, M.A., D.Phil., D.Sc.
J.W. Cowie, B.Sc., Ph.D.
J.G. Prince
V. Dennison, B.Sc.
R.M. Payne, F.R.E.S.

Vice Presidents:

Mrs A.J. Hollowell, M.A., F.M.A.
R.G. Symes

Hon. Treasurer:	P.J.M. Nethercott
Hon. Secretary;	Miss A. Heckels, B.Sc.
Hon. Auditor;	T.B. Silcocks
Hon. Bulletin Secretary:	D.W.B. Frost
Hon. Publicity Secretary:	A.L. Grenfell, F.L.S.
Hon. Circulation Secretary;	Miss S.M. Garden
Chairman, Field Committee:	Mrs V.J. Kenney
Hon. Secretary, Field Committee:	Miss R.C. Lee, Dip. Soc. Stud.
Hon. Librarian:	- vacant -
Hon. Editor:	A.E. Frey, B.A.
Hon. Conservation Liaison Officer:	Miss I.F. Gravestock, B.A.

Officers of Sections:

Botanical	- **President:**	R.M. Payne, F.R.E.S.
	- **Hon. Secretary:**	A.C. Titchen
Entomological	- **President:**	A.H. Weeks
	Hon. Secretary:	G. Best
Geological	- **President:**	D.E.G. Briggs, Ph.D.
	- **Hon. Secretary:**	P.R. Crowther, Ph.D.
	- **Hon. Field Secretary:**	D.A. Wilson
Ornithological	- **President:**	S.M. Taylor, B.Sc., M.I.Mech.E.
	Hon. Secretary:	T.G. Evans

Other Members of Council:

A. Bebbington, Ph.D.
P.J. Chadwick
Mrs G.R. Hamilton
Mrs M. Hamilton
Miss M.E. Jervis, M.A.
C. Little, Ph.D.
N. Malcolm, M.D.
F.H. Rawlings
L.C. Tew

REPORT OF COUNCIL, 1987

Membership at the end of the year stood at 554 including 4 juniors and 4 affiliated societies.

At the Annual General Meeting the Officers and Members of Council were elected with Dr T.E. Thompson as President.

The Annual Buffet Supper was held in April when Mr D.W.B. Frost gave a well illustrated talk entitled "Look closer".

Members of the Conservation Liaison Committee have made representations to the City of Bristol Planning Committee about the application to build houses and flats in Glenavon Park, Stoke Bishop, and on the future of the open land between Lockleaze, Stapleton and Frenchay (Purdown Ridge and the grounds of Stoke Park Hospital).

The Society is represented on the Severn Estuary Conservation Group. To publicise the work of the group, the topic for the November General Meeting was "Severn Estuary Studies".

The February General Meeting was held on a Saturday afternoon when it had a good attendance; the practice will be repeated next year.

Contact has been established with the Cardiff Natural History Society and joint activities are planned.

The family walks held in mid-summer, organised by Mrs V.J. Kenney and publicised by the County of Avon, attracted a good response from the public.

A photographic competition, the Portman 1988 Wessex Natural History Colour Slide Competition, has been organised jointly by the Society and the Filton Camera Club: the competition has been generously supported by sponsors Portman Building Society. The public showing of the slides and presentation of awards will be in April 1988.

We record with regret the deaths of the following members during 1987: Dr T.E.T. Bond, Miss M. Bottoms and Mr H.S. Walker. Also of former members Mrs W. Cummins and Miss E.J. Lenton.

ACCOUNT OF GENERAL MEETINGS, 1987

January:	Annual General Meeting & Presidential Address - "The World of Grass", by Mr R.M. Payne, postponed due to atrocious weather conditions.
February:	Annual General Meeting followed by "The Natural History of the Camargue", by Mr S.M. Taylor. (Afternoon meeting).
March:	"Bristol's Poisonous Plants", Mr A.C. Titchen.
October:	Fungi - "The Good, the Bad and the Unexpected", by Dr Madelin.
November:	"Severn Estuary Studies", by Dr C. Little et al.
December:	"The World of Grass", by Mr R.M. Payne. (Deferred Presidential Address).

AUDREY HECKELS, **Hon. Secretary**

GENERAL FIELD MEETINGS, 1987

A full account of the following meetings is kept in the records of the Field Committee:

31 Jan Miss R.C. Lee. The Wildfowl Trust, Slimbridge. A sunny but very cold day: ice on all the water meant no flocks of ducks or geese visible from the hides, which was disappointing, but members enjoyed seeing the collection under excellent conditions.

17 Apr Miss R.C. Lee. Forest of Dean. A most enjoyable meeting on a gloriously sunny and warm Good Friday. Many spring flowers were seen and some summer migrant birds heard. Five species of butterfly noted, including a Wood White. Afternoon visit to the Dean Heritage Museum at Soudley, following walk around Soudley Pools.

7 May Mr D.A.C. Cullen. Evening visit to Inglestone Common on a warm May evening. Excellent birdsong and good warbler sightings. 5 Nightingales heard towards the end of the evening. Woodland flora noted.

16 May Miss M.E. Jervis. Southern Malverns. Walk through woods and over common land of the south-eastern foot of the hills. Birdsong from a variety of woodland and hedgerow species noted in sunshine. A good selection of plants. Geology of the area noted at a quarry. Climb to the British Camp with good views over Severn Vale in the afternoon.

20 Jun Dr N. Malcolm. Berrow Dunes. A most rewarding afternoon in fine weather spent exploring the rich flora. Features of the structure of the dunes pointed out by the leader.

18 Jul Mrs V.J. Kenney. An interesting visit to Manor Farm, Kingston Deverill, Wilts. which is run by Mr David Stratton (in conjunction with the Countryside Commission) as a demonstration farm, combining farming with wildlife conservation. Farming features and practices were explained and the flora of areas of chalk downland and scrub noted.

26 Aug Mrs V.J. Kenney. An informative evening visit to Sharpness Docks and Canal where, despite poor weather, many plants were noted on derelict land and flocks of gulls seen on the estuarine sand.

12 Sep Dr N. Webb. An exceptionally interesting visit, in atrocious weather, to Stoborough Heath, adjacent to the Hartland Moor NNR nr Wareham. Most noteworthy were Dorset Heath, Yellow Bartsia, Marsh Gentian, Bog Orchid, a Sand Lizard and Raft Spider.

24 Oct Miss M.E. Jervis. A walk to the top of Painswick Beacon and then through woods on the Cotswold Way to Cooper's Hill. All in glorious sunshine with fine autumn colours. Woodland birds, many flowers of summer still in bloom and a few fungi seen.

21 Nov Mrs V.J. Kenney. Circular walk from the River Severn at Newnham, along lanes and over fields, to the Blaise Bailey viewpoint in the Forest of Dean and back. Autumn colours still in evidence on a grey November day and a few flowers still in bloom, but few birds.

RACHEL LEE, **Hon. Secretary, Field Committee**

REPORT OF THE BOTANICAL SECTION, 1987

At the Annual General Meeting, held in the Schools Room of the City Museum on 26 January 1987, the following were elected: **Hon. President**: Mr R.M. Payne (succeeding Lady Rosemary FitzGerald who resigned in 1986); **Hon. Secretary & Treasurer**: Mr A.C. Titchen; **Committee**: Mr A.L. Grenfell, Dr C.M. Lovatt, Mr M.A.R. Kitchen, Mrs C. Kitchen, Miss I.F. Gravestock, Mr P.J.M. Nethercott, Mrs N. Vaughan-Davies, Mrs M.A. Silcocks, Ms L. McDonnell and Mr P.J. Martin.

The following winter meetings were held:-

26 Jan	Annual General Meeting & Members' Evening.
23 Feb	English Mountain Plants, Dr P. Thompson.
23 Mar	Westonbirt Arboretum - its History & Trees, Mr A.C. Titchen.
26 Oct	Current land use studies of the NCC in Avon, Mr J. Scott.
23 Nov	Members' Evening with slides.
14 Dec	"Of Cabbages and Kings - the Cruciferae", Dr T.C.G. Rich.

The following field excursions took place, under the leadership of those shown:-

26 Apr	Fyne Court, Somerset, Ms Liz McDonnell.
9 May	Sand Bay, Kewstoke, Mrs M.A. Silcocks.
27 May	Leigh Woods, Mr P.J.M. Nethercott.
3 Jun	**Hieracia** and other plants, Ms Liz McDonnell.
11 Jun	Bishop Knoll, Sea Mill, Miss I.F. Gravestock.
14 Jun	Kew Gardens, Mr A.C. Titchen.
17 Jun	Plants of Clifton Downs, Mr A.C. Titchen.
11 Jul	Wavering Down, Mr P.J.M. Nethercott.
15 Jul	Sodam Mill, Glos., Mr M.A.R. Kitchen.
8 Aug	Trees of Bishopston & Horfield, Mr N. Vaughan-Davies.
6 Sep	Clutton area, Mr R.M. Payne.

Members of the Section assisted with plant identification in connection with Flora of Avon meetings.

TONY TITCHEN, **Hon. Secretary**

REPORT OF THE ENTOMOLOGICAL SECTION, 1987

On the date fixed for the Annual General Meeting (22 January 1987) four members were present. The President declared that, in the absence of a quorum, business would be deferred to a later meeting and he declined to give his Presidential Address.

On March 19th, the Officers then in office and the current Committee agreed to remain in office, viz. **President**: Mr A.H. Weeks; **Secretary**: Mr G.R. Best; **Treasurer**: Mr R.W. Rowe; **Committee**: Mr R.S. Cropper, Dr K.W. Miller, Mr R.M. Payne, Mr K.H. Poole, Mr S. Randolph and Mr G.W. Sorrell.

The winter programme included the following indoor meetings:-

22 Jan	Annual General Meeting (abandoned).

19 Feb Recorders' Reports.
19 Mar Extraordinary General Meeting.
8 Oct Members' Evening and review of summer activities.
10 Dec Annual General Meeting and Presidential Address, "Relationships between Climate and Wildlife, especially Insects".

Field meetings held in the summer were:-

26 Apr Cadbury Hill, Congresbury & Yatton, Mr A.H. Weeks (joint with Avon Wildlife Trust, Cadbury Hill Group).
30 May Cleaves Wood nr Wellow, Mr A.H. Weeks.
1 Aug Catcott Heath, Dr K.W. Miller & Mrs P. Hill-Cottingham (STNC).
23 Aug Ashton Court, Mr S. Randolph.
5 Sep River Chew, Compton Dando, Mr R.M. Payne.

A projected survey of selected sites on Broadfield Down was eventually discontinued due to lack of support: meetings took place on 11 April, 9 May, 13 June and 11 July (on the latter two dates only the leaders turned up). Rather indifferent weather on some of the chosen dates contributed to the poor attendances.

At the Annual General Meeting on 10 December, it was decided not to hold further indoor meetings in the early part of 1988, but to arrange a limited number of field meetings in the summer, these to be announced in the Bulletin.

GRAHAM BEST, **Hon. Secretary**

REPORT OF THE GEOLOGICAL SECTION, 1987

At the Annual General Meeting held on 18 Feb 1987 the following were elected: **President**: Dr D.E.G. Briggs; **Vice-Presidents**: Dr D. Hamilton and Mr M. Curtis; **Hon. Secretary**: Dr P.R. Crowther; **Hon. Treasurer/Field Secretary**: Mr D.A. Wilson; **Committee**: Mrs G. Hamilton, Mrs M.E. Poolman, Mr D. Cope and Mr V. Dennison.

The following winter indoor meetings were held:

18 Feb Annual General Meeting followed by "The Geology and Scenery of Shetland", by Mr D.A. Wilson.

6 Mar "The Causes of Ice Ages", by Mr M. Walford.

21 Oct "The Life of Trilobites", by Dr Euan Clarkson (Edinburgh University).

18 Nov "The Dolomitic Conglomerate - a problem solved?", by Mr C. North.

9 Dec Members' Evening.

The following field meetings were held:

9 May Hampstead Farm Quarry, Chipping Sodbury, Mr M. Curtis.

18 Jul The Gordano Valley, Mr Charles Copp.

13 Sep Ladye Bay, Clevedon, Posrtskewett and Beachley, Mr C. North.

PETER CROWTHER, **Hon. Secretary**

STATEMENT OF ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1987

Income and Expenditure for the year ended 31 December 1987

1986	Income	1987
3256	Members' Subscriptions	3176
542	Income Tax repayment	298
99	Donations	67
224	Sale of Proceedings and grant	264
370	Sale of Books	328
-	General field meetings, profit	76
27	Buffet Supper, profit	32
160	Bank interest	217
4678		4458
	Expenditure	
805	Printing and stationery	859
462	Postage and telephone	450
1345	Proceedings and Bird Report (1066 and 458)	1524
63	Library, books	150
-	binding and repairs	350
205	subscriptions and purchases of journals	153
25	fire insurance	50
8	Donations	11
228	Indoor meetings	230
10	General field meetings, loss	-
75	Grants to Sections	165
3226		3942
£ 1452	Surplus for year	£ 516

Balance Sheet as at 31 December 1987

1986			1987
4000	Government stocks at purchase price		4000
466	National Savings Bank		941
739	Cash at Banks - current accounts		525
2925	- do - - deposit account		3942
10	Prepayment		10
8140			9418
1293	Less Creditors (subscriptions in advance 198, binding 112, bulletins 109, Proceedings 1041, hire of rooms 120)		1580
6847			7838
	Represented by:		
206	Harry Savory Illustrations Fund		206
93	Conservation Appeal		93
4466	Hector Hockey Memorial Fund		4941
2082	General Fund at 31 December 1986	2082	
	Add surplus on year	516	2598
£ 6847			£ 7838

NOTES (1) No value is placed upon the contents of the Library and stocks of publications.

Special Funds

Receipts and Payments for the year ended 31 December 1987

1986		1987
	Harry Savory Illustrations Fund	
206	Fund at 31 December 1986 & 31 December 1987	206
	Conservation Appeal	
93	Fund at 31 December 1986	93
	Additions to Appeal in 1987	50
		143
	Grant to Taff-Ely Barrage Appeal	50
93	Fund at 31 December 1987	93
	Hector Hockey Memorial Fund	
4466	Fund at 31 December 1986	4466
	Additions to Fund in 1987 (interest)	475
£ 4466	Fund at 31 December 1987	£ 4941

(2) These accounts do not record balances held by sectional treasurers or the Ornithological Section Special Fund of £476.

(3) The Government stocks are £2032.10 10½% Treasury Stock 1989 and £2000 Income Bonds.

P.J.M. NETHERCOTT
PJM Nethercott

Hon. Treasurer
13 June 1988

Audited and found correct
T.B. Silcocks
TB Silcocks

Hon. Auditor
10 August 1988

REPORT OF THE ORNITHOLOGICAL SECTION, 1987

At the 63rd Annual General Meeting held on Wednesday, 28th January 1987, Dr H.E. Rose was re-elected **President** and Mr T.G. Evans was elected **Secretary** and **Treasurer.** Mr S.M. Taylor was elected **Assistant Secretary.** Mr B. Tizard retired from the Committee by rotation and Mrs M.A. Hamilton and Mrs M.J. Morgan were elected to it. Dr Rose's Presidential Address entitled 'Spring in Eilat' gave a lasting impression on raptor passage migration and was very well received.

Other indoor meetings covered the work of the Avon Wildlife Trust, the postponed lecture on Farming and Wildlife by Dr O'Connor, the Birds of Rural Gwent and a talk by Rae Vernon on the Birds of Panama. A film evening was held on December 9th.

A joint fieldwork meeting was held with the Bristol Ornithological Club which was hosted by this Society. Among other work, the Birds in Gardens and Overwintering Warblers surveys were updated.

Eight winter walks were held and thirteen took place during the summer programme.

TREVOR EVANS, **Hon. Secretary**

LIBRARY REPORT, 1987

During the year, the library opening hours have been maintained, namely two hours on Saturday mornings and half an hour on Wednesdays. A brief guide to the library has been produced. This will be circulated to members; it outlines the holdings of books and journals, the arrangements for using the library and the layout of the library shelves. A limited number of library working parties has been held and the main achievement has been the completion of the shelf-marking of the books.

Money from a sale of surplus books has allowed for some binding of issues of The Entomologist's Record, British Birds and BNS Proceedings and for repairs to a number of books and journals.

During the year, 212 visits have been made by 41 members who, between them, borrowed 185 items. Visits by Museum & Art Gallery staff totalled 31, including use made of the library holdings by the Curator of Fine Art researching his exhibition on the Frampton Flora, on show from 4 April - 30 May 1987.

This year four books have been purchased. Currently 13 journals (including Reports and other Serials) are received on subscription and 70 by exchange. We have been given three books and 63 issues of journals for which we are indebted to Mr D.R. Foster, Mr P.J.M. Nethercott, The Mendip Society, Mr R. Janes, Miss M.E. Bridge and Mr D.A. Wilson.

The post of Honorary Librarian has been vacant during the year.

We would like to express the Society's gratitude to Mr M. Heighton, Director of Arts, Bristol City Council and to Mrs H. Woolley, Assistant Director, City Museums and Art Gallery for the use of the library room during the year. We are also indebted to the University for continuing to afford us some storage space for periodicals.

ANNE F. HOLLOWELL, **Chairman, Library Committee**

GUIDANCE FOR AUTHORS

1) The editor welcomes original papers on the natural history of the Bristol region*, which will then be considered for the Proceedings by a publications committee.

2) Manuscripts should be double-spaced with adequate margins to allow corrections and amendments. A copy should be retained by the author.

3) All items for publication should reach the editor by the end of February in each year. If there is likely to be a problem with this target date please ring the editor.

4) The Proceedings has a style and format which should be followed and it is especially important that the writing should have an abstract, be broken up by appropriate headings/sub-headings and include illustrations/photographs of a suitable nature.

5) Abbreviations should not normally be used, especially in the references.

6) References should be listed in alphabetical order at the end of the paper, and take the following form:-

Book:- AUTHOR (DATE). TITLE. PLACE OF PUBLICATION. PUBLISHER.

e.g. RACKHAM, O. (1986). The history of the countryside. London, J.M. Dent.

Article:- AUTHOR (DATE). TITLE. JOURNAL NAME, VOLUME, PART, PAGE NUMBERS.

e.g. ROSS, S.M. & HEATHWAITE, A.L. (1986). West Sedgemoor: its peat stratigraphy and peat chemistry. Proceedings of the Bristol Naturalists' Society, **44**, 19-25.

7) Originals, not copies, of photographs, slides, line drawings, diagrams and maps should be submitted - they will be returned on request. Drawings and other diagrams should be not more than twice final size and made in black medium. Photographs and slides, preferably monochrome, may be submitted as prints, positives or negatives.

8) Captions to illustrations should be appended to the end of the paper.

9) An abbreviated title for use in the running heading should be supplied.

e.g. NATURE CONSERVATION IN THE BRISTOL REGION: AN ACCOUNT OF THE WORK OF THE SOCIETY'S CONSERVATION COMMITTEE

may be abbreviated thus:-

NATURE CONSERVATION IN THE BRISTOL REGION

10) The copyright of all published material will belong to Bristol Naturalists' Society, whose Council can authorise reproduction.

11) Reprints (not covered) are available to authors at 25p per copy. Please indicate how many reprints you will require when submitting your paper.

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* The Bristol region is construed as extending from the Vale of Berkeley in the north, the River Avon in the east and the Somerset Levels to the south, although these are at best approximate boundaries.

EDITOR'S REMINDER

This issue of the Proceedings is the first to concentrate on a theme, "The Avon Gorge", and it is to be followed by another theme issue - "Bristol's Urban Ecology", the 1988 Proceedings which will be published later this year.

Several papers have already been offered for this 'urban ecology' issue and are in the process of being written up. If you have any material which would be suitable for this theme, please contact the Editor.

For the following year (the Proceedings for 1989) we shall revert to the more traditional format in which papers on any topic relevant to natural history in the Bristol region will be published.

In future years, we shall alternate between some years in which special theme issues are published and others dealing with more general subjects. If there are any themes which you think we could adopt in the future, please give the Editor a call on Bristol 243123 (evenings) or 303030 ext. 3848 during the day - he would be happy to talk about any aspect of our publication policy and practice.

ALLAN FREY, **Hon. Editor**

USEFUL INFORMATION

The President of the Society is:-

Miss R.C. LEE,
78 THE DELL, WESTBURY-ON-TRYM,
BRISTOL BS9 3UG

All articles for inclusion in the next issue of the Proceedings should be sent to:-

Mr A.E. FREY, B.A., HON. EDITOR,
DEPARTMENT OF GEOGRAPHY,
UNIVERSITY OF BRISTOL,
BRISTOL BS8 1SS

NOT LATER THAN 28th FEBRUARY, 1989.

See also 'Guidance for Authors' on page xi.

All Books, Pamphlets, Reports of Proceedings sent by way of exchange, gift or otherwise, and all correspondence relating thereto and to purchases of the Society's publications should be addressed to:-

HON. LIBRARIAN,
BRISTOL NATURALISTS' SOCIETY,
THE CITY MUSEUM,
BRISTOL BS8 1RL

Applications for membership of the Society should be addressed to the Hon. Treasurer:-

Mr P.J.M. NETHERCOTT,
6 HAZELWOOD COURT, HAZELWOOD ROAD,
BRISTOL BS9 1PU

Enquiries concerning Field Meetings should be made of the Hon. Secretary, Field Committee:-

Miss R.C. LEE (address above).

All other communications should be addressed to the Hon. Secretary:-

Miss A. HECKELS, B.Sc.,
8 RIDGEWOOD, KNOLL HILL,
SNEYD PARK, BRISTOL BS9 1QZ

The SOCIETY'S LIBRARY is housed in the City Museum and is available to members at times which are advertised in the Society's Bulletin.

OBITUARY: ELIZABETH J. LENTON (1927-1987)

Elizabeth Lenton, known to all as Libby, was a member of this Society from 1963 until 1983 when she resigned on leaving the district. She came to live in Bath in the early sixties and taught at the Bath High School for Girls until 1977. Her interest in wildlife is well remembered by her former pupils.

Libby is particularly remembered by the Bristol Naturalists' Society for the contributions she made to the Mammal Section and to the Junior Section, indeed at one time she was Secretary to both those Sections. She led many field meetings for the Society, including seal weekends in Pembrokeshire, and infected all with her interest and enthusiam. She impressed all by her fieldwork and knowledge. However, her abilities were not limited to those areas and she also contributed to ornithological and botanical recording, and to The Flora of Somerset. In all her activities with the Society she encouraged participation by junior members.

In 1977, Libby resigned her teaching post to take part in the Otter Survey of England on contract to the Nature Conservancy Council. Otters had been a great love and passion of hers for many years and she had systematically surveyed river systems in the area, enduring the gentle ribbing of friends that in all that time she had not seen an otter! She spent two years touring England recording otter activity and a report incorporating her findings was published in 1980. She then joined the Vincent Wildlife Trust Otter Haven Project and worked in south-west England for the next five years.

At Libby's initiative, the Mammal Society launched a Youth Group in 1978 With Libby as Chairman and Membership Secretary; she also produced a project book for youngsters entitled 'Discovering Mammals', published by the Mammal Society. She became Editor of that Society's Newsletter at a difficult time and she was posthumously awarded the Mammal Society's Silver Medal in 1988, the medal being accepted by her brother David.

Libby Lenton did much to encourage interest in wildlife in the Bristol district and, more widely, throughout the rest of the country. She was greatly respected and loved by all who knew her. Elizabeth Lenton died on Christmas Day 1987; those who knew her will not forget her.

R.G. SYMES

Proceedings of the Bristol Naturalists' Society (1987), **47:** xv-xxii

AVON AND DISTRICT ENTOMOLOGICAL REPORT, 1987

Compiled by the Recorders of the Entomological Section:

R.S. Cropper S. Randolph
K.W. Miller R.W. Rowe
R.M. Payne G.W. Sorrell
K.H. Poole A.H. Weeks

Insects need sunshine and warmth for maximum activity. Observers need reasonable conditions before embarking on sometimes long journeys if they are to have any hope that these might be rewarding. Sadly, there were not many ideal moments in 1987 and few of these coincided for "hunters" and "hunted". The general feeling is that less was seen and done this year than for many seasons. Almost certainly the volume of records made during the Common Butterfly Survey undertaken by the Bristol Regional Environmental Records Centre (BRERC) was lower than usual, but the Section is nevertheless grateful to have had these records made available to augment those from Society members.

In addition to the Recorders listed above, contributors include R. Angles and P. Crocker.

WEATHER SYNOPSIS (compiled by A.H. Weeks)

1987 produced a mixed bag of weather: it left an overall feeling that it was no better than its predecessor, whereas in fact it was marginally better. Winter, commencing December 1986, started warm and very wet but ended colder than average, mainly because of a severe spell of ten days in mid-January and a shorter, less severe period in mid-February. The mean temperature in January was 3°C below normal but sunshine was normal and rainfall was low, at less than 25%. February's figures were slightly below average for all three. Spring was warmer and drier than average. Although it started inauspiciously with a cool, wet and rather dull March, April more than made up for this with a very satisfactory mean temperature more than 2°C above average, normal sun and rain. May was a trifle on the cool side but rainfall was only half of average and sunshine was above normal. There was a welcome spell from 11 April to 10 May during which significant rain fell only on 1 May.

The West Country escaped the excess of rain from which many other parts of the country suffered during the summer. Here the dry spell continued, the season ending with less than two-thirds of normal rain. June and July were a little cooler than normal, with a shortage of sun, particularly in June, but August was warm and sunny and very dry (little more than one-third of average rain). Autumn continued dry, September producing three-quarters of average rainfall, but October reversed the trend and gave nearly double. Both months were normal for temperature and sun, while November was cool, quite dry and rather dull. December (the first month of the 1987/88 winter) was slightly warmer than average, with half normal rain but also normal sunshine. Overall, the year's mean temperature was a fraction of a degree higher than average, rainfall was about 80% of normal, but sunshine was well down. It was this last factor which, as described below, reduced opportunities for observations in the field.

BUTTERFLIES (Lepidoptera) by A.H. Weeks

The volume of records received from members was smaller even than in 1986, as were reports to BRERC. This was undoubtedly due to the variable weather which restricted opportunities for field visits. August was the only month in which conditions favourable for recording lasted for more than a day ot two at a time. June, one of the peak months for butterflies, was the least favourable. When opportunities did arise for field visits, it appeared that most species were present in reasonable numbers.

Although there was some strong sunlight from the end of February onwards, below-average air temperatures brought about by cool breezes prevented nearly all butterfly activity in March. April brought much fairer conditions, the hibernators soon roused and the spring species appeared in quick succession. One or two species were seen on the earliest dates for some years, e.g. the Green Hairstreak before the end of April and the Large Skipper before the end of May. Of the spring species, the Orange Tip was probably the most successful. The Holly Blue remained elusive, but the Common Blue and Brown Argus staged a partial recovery after a couple of poor seasons.

The summer browns appeared on time but still mostly with reduced populations: the Marbled White alone appears to have maintained near-normal numbers, although Small Heath and Grayling numbers were good. The Speckled Wood appeared in particularly large numbers in late summer. The Skippers suffered another relatively poor season.

The large numbers of Small Tortoiseshells from July to October reflected the good conditions for breeding in April and May. Commas also did reasonably well, but Peacocks were less successful. Of the two common immigrants, the Red Admiral appeared in late July, had a good breeding season and specimens were on the wing until mid/late October. The Painted Lady was rather scarce, appearing in small numbers, mostly in early August and early October. There were very few sightings of that other summer immigrant, the Clouded Yellow. The heavy rains which set in early in October effectively put an end to activity and few records were received for dates after the middle of that month.

The following is a summary of the year's records (for designation of sites and localities, see Proceedings, 1982, 83-84):-

Pieris brassicae (Large White) Common everywhere: from end of April to end of September; abundant mid-August.

P. rapae (Small White) From early April to early October; abundant May and August.

P. napi (Green-veined White) Quite a good year; from mid-April to late August. Most frequent in late April and early August.

Anthocharis cardamines (Orange Tip) A good year; from late April to early June. Frequent in late April.

Colias crocea (Clouded Yellow) Isolated reports: one, Goblin Combe 24 May; one, Crook Peak 12 July; two, Draycott Sleight 25 July and one, Congresbury 9 August.

Leptidea sinapis (Wood White) Again recorded at Harry Stoke, also Stockwood and Willsbridge late May.

Gonepteryx rhamni (Brimstone) Frequent in spring, smaller numbers in summer. From early April to end of May, early August to late September.

Ladoga camilla (White Admiral) Reported only from Inglestone Common, nr Wickwar. Early July to early August, most 17 on 12 July.

Inachis io (Peacock) Not in large numbers in spring but common early August.

Seen early April to end August, then went rapidly into hibernation.

Vanessa atalanta (Red Admiral) From late July to early October; good numbers from mid-August onwards.

V. cardui (Painted Lady) Rather scarce: seen mostly in ones or twos, from end of July to early October in scattered areas.

Aglais urticae (Small Tortoiseshell) A good season. Seen late March to late October; abundant from mid-August onwards (150+ seen near Claverham 30 August).

Polygonia c-album (Comma) Fair numbers from early April to mid-October; most in early August. Widely distributed.

Argynnis paphia (Silver-washed Fritillary) Few reports received. Several, Goblin Combe, Cleeve 11 July to 20 August; one, Weston Big Wood, Portishead, 19 July.

Mesoacidalia aglaia (Dark Green Fritillary) Few reports. Frequent at Charterhouse-on-Mendip/Velvet Bottom and Dolebury Warren, early July: also seen at Brockley Combe, Crook Peak, Goblin Combe, Burrington Combe in July.

Fabriciana adippe (High Brown Fritillary) No reports in vice-counties 6 and 34. Nearest seen: Broomfield, nr Bridgwater, early July.

Boloria euphrosyne (Pearl-bordered Fritillary) Plentiful, Great Breach Wood, nr Compton Dundon 25 May. (Also reported flying with **B. selene**, Charterhouse-on-Mendip/Velvet Bottom, early July).

B. selene (Small Pearl-bordered Fritillary) Quite common on Mendip, early July.

Euphydryas aurinia (Marsh Fritillary) Several, Hollow Marsh, nr Farrington Gurney 30 May; also at Ashcott, nr Street 8 June.

Melanargia galathea (Marbled White) Well distributed, from late June to mid-August. Most at Kingsweston Down and Arno's Vale Cemetery, Bristol; Dolebury Warren and Cheddar Valley Railway track, nr Yatton Station, early July.

Hipparchia semele (Grayling) Reasonable numbers, mostly along the line of the Mendips, from early July to late August: most at Brean Down 16 August, Goblin Combe 10 August; also Draycott Sleight and Dolebury Warren.

Maniola jurtina (Meadow Brown) Widely distributed but numbers not up to average. From late June to late August, peak late June/early July, especially Dolebury Warren 2 July, Kingsweston Down 30 June and Cadbury Hill, nr Yatton 5 July.

Aphantopus hyperantus (Ringlet) Only a fair season, late June to early August. Most at Dolebury Warren 2 July, Cadbury Hill, nr Yatton 5 July and Arno's Vale Cemetery, Bristol 18 July.

Pyronia tithonus (Gatekeeper) Numbers well down on average: from late July to to early September. Most at Catcott Heath 1 August, Goblin Combe 10 and 20 August and Draycott Sleight 16 August.

Coenonympha pamphilus (Small Heath) Quite a good year, late May to late August. Most at Dolebury Warren 2 July, Charterhouse-on-Mendip/Velvet Bottom 2 July and Goblin Combe 1 July.

Pararge aegeria (Speckled Wood) Widespread but numbers comparatively low in spring, picking up in early July and especially late August/September.

Lasiommata megera (Wall) Remaining quite scarce. Sighted only at Goblin Combe

26 May, Berrow Sands 26 May and Draycott Sleight 16 August.

Hamearis lucina (Duke of Burgundy Fritillary) Reported only from Midger Wood, mid-May to early June.

Quercusia quercus (Purple Hairstreak) Few reports: 6, Walton Down, nr Clevedon 14 August, Great Breach Wood, nr Compton Dundon 7 July and Goblin Combe 20 August.

Strymonidia w-album (White Letter Hairstreak) Reports from Ashton Hill, Bristol 26 July, Lord's Wood, nr Pensford 1 August and Coombe Dingle, Bristol, 3 August.

Callophrys rubi (Green Hairstreak) Few reports: Goblin Combe 28 April, Dolebury Warren 6 May and Cleaves Wood, nr Wellow 30 May.

Lycaena phlaeas (Small Copper) Only small numbers reported late June to late September. Most: four at Catcott Heath 1 August, three at Purton, nr Sharpness 25 August and four at Compton Dando 5 September.

Aricia agestis (Brown Argus) Some recovery from previous poor years but still relatively scarce. From early July to mid-September. Reports of more than one only from Sand Point 19-20 May, Crook Peak 14 June, Fry's Hill, Axbridge 23 August, Dolebury Warren 28 August and Goblin Combe 18 September.

Cupido minimus (Small Blue) Late June and early July: fair numbers at Worlebury 11 June, Dolebury Warren 12 June and 2 July, Draycott Sleight 2 July and Charterhouse-on-Mendip/Velvet Bottom 1 July.

Celastrina argiolus (Holly Blue) Spring brood, one, Crook Peak 26 April. Summer brood, Weston-super-Mare 23 July, Backwell 14 August, Congresbury 5 September.

Lysandra coridon (Chalkhill Blue) Abundant, Draycott Sleight August; Uphill, six on 20 August.

Polyommatus icarus (Common Blue) Widespread with a slight recovery from poor numbers in 1985-86. From late May to September. Highest counts: Cleaves Wood, Wellow 30 May, Velvet Bottom 2 July, Goblin Combe 20 August, Purton, nr Sharpness 25 August and Dolebury Warren 28 August.

Pyrgus malvae (Grizzled Skipper) A few seen in late April and throughout May. Most at Dolebury Warren 6 May and Goblin Combe 28 April. Otherwise single specimens at Cheddar, Sandford Hill and Great Breach Wood.

Erynnis tages (Dingy Skipper) Only reports from Dolebury Warren, six on 6 May, several, Sandford Hill 16 May and five, Cleaves Wood, nr Wellow 30 May.

Thymelicus sylvestris (Small Skipper) Only a fair season, late June to early August. Most at Kingsweston Down 30 June, Velvet Bottom 1-2 July, Cheddar Valley Railway track, Yatton 4 July, Cadbury Hill, Yatton 5 July and Weston Big Wood, Portishead 25 July.

Ochlodes venatus (Large Skipper) Numbers improved on 1986. Unusually early sighting at Hollow Marsh, nr Farrington Gurney 30 May; otherwise common throughout July at Arno's Vale Cemetery, Bristol; Kingsweston Down; Snuff Mills, Stapleton, Bristol; Goblin Combe and Cadbury Hill, Yatton.

MOTHS (Lepidoptera) by K.H. Poole

The following records are selected from the few reports received for 1987. The only migrant species noted were the Humming-bird Hawkmoth, the European

Corn-borer and the Silver-Y. Contributors included:- D. Agassiz (DA), R. Angles (RA), C.S.H. Blathwayt (CSHB) and R.W. Rowe (RWR).

Macroglossum stellaratum (Humming-bird Hawkmoth) Churchill, no date (DA); Congresbury, 12 June (RWR).

Furcula furcula (Sallow Kitten) Congresbury, 4 August (RWR).

Notodonta dromedarius (Iron Prominent) Congresbury, 4 August (RWR).

Tetheella fluctuosa (Satin Lutestring) Leigh Woods, 27 July (KHP).

Colocasia coryli (Nut Tree Tussock) Congresbury, 18 May, 29 August (RWR).

Rhyacia simulans (Dotted Rustic) Worle, Weston-super-Mare, 27 June (KHP per Alec Coles).

Melanchra suasa (Dog's Tooth) Middle Hope, Weston-super-Mare, 6 July (KHP).

Hadena confusa (Marbled Coronet) Weston-super-Mare, 2 July (CSHB).

Lithophane leautieri (Blair's Shoulder Knot) Weston-super-Mare, early November (CSHB per J. Hadley).

Allophyes oxycanthae (Green Brindled Crescent) Congresbury, 26 October (RWR).

Omphaloscelis lunosa (Lunar Underwing) Congresbury, 20 September (RWR).

Apamea crenata (Clouded-bordered Brindle) Congresbury, 26 May (RWR).

A. ophiogramma (Double Lobed) Leigh Woods, 27 July (KHP).

Polychrysia moneta (Golden Plusia) Congresbury, 30 June (RWR).

Cyclophora linearia (Clay Triple-lines) Weston-super-Mare, 5 July (KHP).

Perizoma bifasciata (Barred Rivulet) King's Wood, Cleeve, 8 August (KHP).

Discoloxia blomeri (Blomer's Rivulet) Leigh Woods, 27 July (KHP).

Abraxas sylvata (Clouded Magpie) Weston-super-Mare, 30 September, larvae; Leigh Woods, 27 July (KHP).

Semiothesa clathrata (Latticed Heath) Uphill, Weston-super-Mare, 17 July (RA); Weston-super-Mare, 20 June (KHP), 20 August (RA).

Biston betularia (Peppered Moth) Congresbury, 28 June (RWR).

Ostrinia nubilalis (European Corn-borer) Berrow, 13 July (KHP per E.A. Dean). A rare immigrant, now becoming established along the south coast. This would seem to be the first record for our area.

The following "micro-lepidoptera" would also appear to be new to the Somerset area (DA):-

Biselachista utonella, Shapwick

Coleophora saxicolella, Churchill.

Anacampsis blatteriella, Shapwick.

Celypha woodiana, common in the Churchill-Congresbury area.

Eucosmomorpha albersana, Churchill.

Dichrorampha aeretana, Dolebury Warren.

Pyraustra ostrinalis, Dolebury Warren. (Specimens from Worlebury, Weston-super-Mare, 1940 and 1987 appear to be this species - KHP).

Names in accordance with "British Butterflies and Moths", by J.D. Bradley and D.S. Fletcher, 1979.

BEETLES (Coleoptera) by R.W. Rowe

The low level of activity in the Entomological Section at the time of writing these notes is reflected in the number of reporters supplying information for 1987. These records have come from only two members and the species recorded can hardly be said to be representative either of the year or area.

The nomenclature followed is that given in Kloet and Hincks "A Check List of British Insects", Vol. XI (2), 2nd Ed., 1977.

Longitarsus nigerrimus Several under driftwood, Sand Bay, 26 April (RSC).

Elaphrus uliginosus One from bare peat around pool, Tealham Moor, 26 April (RSC).

Donacia marginata One in rhine, Edington Heath, 22 August (RSC).

Denticollis linearis One from hazel, Great Breach Wood, 25 May (RSC).

Anthonomus pedicularius One beaten from hawthorn, Shipham, 4 May (RWR).

Melolontha melolontha One taken at light, Congresbury, 25 May (RWR).

Pyrochroa serraticornis One on garden door, Congresbury, 25 May (RWR).

RSC = R.S. Cropper RWR = R.W. Rowe

LADYBIRDS (Coccinellidae) by K.W. Miller

Coccidula rufa (Herbst)

Anisosticta novemdecimpunctata (L.) (19-spot Ladybird)

Calvia quattuordecimgutta (L.)

All three species recorded by R.S. Cropper from Westhay Heath (Som.) on 26 September and the third named also from Coleford (Som.), 21 June and Weston Milton (Avon), 23 May.

GRASSHOPPERS & CRICKETS (Orthoptera) by K.W. Miller

The following records were all contributed by R.S. Cropper to whom many thanks. Contributions from other members in 1988 would be greatly appreciated.

Stethophyma grossum (L.) (Large Marsh Grasshopper) Westhay, Somerset, 5 September. Two males. This spectacular insect, the largest of the British Grasshoppers, is restricted to wet bogs and, with the increasing loss of this type of habitat in the south of England, it now occurs only in the Somerset Levels and on the south coast in the New Forest/Purbeck area. Bob Cropper has been reporting it regularly for some years from the STNC reserve where it is only just holding on.

Myrmeleotettix maculatus (Thun.) (Mottled Grasshopper) Friars Hill, Axbridge, 23 August in good numbers.

Platycleis denticulata (Panz.) (Grey Bush Cricket) Brean Down, 16 August, singing in good numbers in usual place. A very local species which is largely restricted to coastal areas in the south and west.

Tettigonia viridissima (L.) (Great Green Bush Cricket) Star Common, 1 August.

TRUE BUGS (Hemiptera/Heteroptera) by R.S. Cropper

No outstanding finds were made in 1987 and insect numbers still seem to be rather low. Despite a better summer, the previous two poor ones, together with the cold winter, may still be having an effect. All records R.S. Cropper and single specimens unless otherwise stated.

Elasmotethus interstinctus Several on birch, Westhay Heath, 26 September.

Elasmucha grisea On birch, Westhay Moor, 26 September.

Himacerus apterus On ash in old railway cutting, Cossington, 5 September.

Harpocera thoracica On hawthorn, Catcott Heath, 25 May.

Plagiognathus albipennis Three on mugwort (**Artemisia vulgaris**), Berrow 29 August.

Dryophilocoris flavoquadrimaculatus Landed on car, Great Breach Wood, 25 May.

Calocoris quadripunctatus Two from laneside hedgebank, Cranmore, 7 June.

Pantilius tunicatus On birch, Westhay Heath, 26 September.

Mesovelia furcata On floating algae, Chilton Moor, 22 August.

Ranatra liniaris Nymph in pool, Chilton Moor, 22 August.

Notonecta maculata Many in cattle trough, Backwell Hill, 26 September; several in quarry pool, Stoke St. Michael, 4 October.

Corixa panzeri In ten-acre lake, Westhay Moor, 20 September.

Sigara distincta Two in peaty pool, Tealham Moor, 26 July.

SAWFLIES, BEES, WASPS, ANTS etc. (Hymenoptera) by R.M. Payne

During 1987 "The Natural History of the Chew Valley" was published, containing a list of 73 species of Hymenoptera recorded in that area. When one considers that the Hymenoptera form the largest order of insects in Britain - some 6,500 species - it can be seen that we have a very long way to go before we have a real idea of the range of these insects to be found locally. The following are the more noteworthy records that have come to hand this year:-

SYMPHYTA (Sawflies)

Hartigia xanthostoma Cleaves Wood, Wellow.
Zaraea fasciata East Harptree, Ebbor Gorge (SR).
Tenthreda livida East Harptree.
Macrophya punctum-album Cleaves Wood (SR).

ACULEATA (Bees, Wasps & Ants)

Episyron rufipes Berrow (SR).
Entomognathus brevis Crook Peak.
Nysson spinosus Priddy.
Andrena angustior Ubley.
Lasioglossum fratellum Crook Peak.
L. laevigatum Cleaves Wood (SR).
Hoplitis spinulosa Cleaves Wood.
Nomada hirtipes Cleaves Wood (SR).
N. ruficornis Cleaves Wood (SR).

All records RMP unless indicated otherwise. SR = S. Randolph.

ERRATA

AVON AND DISTRICT ENTOMOLOGICAL REPORT, 1986

p.54 delete entries for **Apamea furva** Denis & Schiff. (The Confused).
and **Lycia hirtaria** Clerck (Brindled Beauty).

Proceedings of the Bristol Naturalists' Society (1987), **47**: xxiii-xxxi

BRISTOL BOTANY IN 1987

by A.J. WILLIS

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The weather in 1987 was rather warmer and drier than in 1986, but the hours of sunshine in both years were very close indeed to the long-term average. Rainfall in 1987 was 822.8 mm, 94% of average, October being by far the wettest month with more than twice the rainfall of any other. In contrast, January and August were very dry, with only about one-quarter of the average rainfall. Although the temperature for the whole year was about average at Long Ashton Research Station, to which all meteorological records relate, the first six months, except April which was warm and sunny, were of below average temperature; in particular January was very cold, with a lowest minimum of -11.9°C. This weather resulted in rather late spring growth and June was a poor month with below average temperature, only three-quarters of average sunshine, and was the second wettest month. In contrast, the last six months of the year were mostly warmer than average, giving growth well into the autumn. The hurricane of 16 October which devastated large parts of south-eastern England fortunately had little effect in the Bristol area.

Much of the Gordano valley is a designated Site of Special Scientific Interest and on 6 July 1987 the Nature Conservancy Council declared and opened The Gordano Valley National Nature Reserve. This covers 66 hectares to the south-west of Walton Drove (which runs from Walton-in-Gordano south-eastwards across the valley). Sir William Miles, as landowner, and his tenants made the management agreement possible. Also the NCC bought the freehold of 60 acres from another landowner. Relatively undisturbed fen-land is becoming increasingly scarce because of drainage operations; conservation of this surviving area, with management designed to maintain the existing communities and the conditions needed for the persistence of rare species, is much to be welcomed. Fortunately the small population of the nationally rare **Cyperus fuscus** still persists as well as notable water plants including **Myriophyllum alterniflorum, M. verticillatum, Hippuris vulgaris, Baldellia ranunculoides, Potamogeton coloratus** and **Eleogiton fluitans** (for an account of the plant ecology of the valley see A.J. Willis and R.L. Jefferies in these Proceedings for 1958, pp. 469-490).

Conservation activities in recent years have helped to restore ancient woodland and other sites of considerable botanical interest. In Leigh Woods, for example, clearance of sycamore, holm oak and Norway maple has been undertaken as well as tree surgery and repairs to walls. It is encouraging that The National Trust is taking more active steps to manage its properties at Cheddar, King's Wood, Wavering Down and Crook Peak. At Cheddar Gorge the Trust's policy is to clear scrub selectively from the roadside and adjacent rock exposures to restore the appearance of parts of the Gorge to the more open habitat that it was formerly. This should promote the distinctive herbaceous flora when coupled with suitable grazing. The pilot project under way should yield useful guidance for future management.

In an interpretation of Leigh Woods, Dr Oliver Rackham has confirmed their ancient character (see Archaeological Aspects of Woodland Ecology, ed. M. Bell and S. Limbrey, Symposia of the Association for Environmental Archaeology No. 2, B.A.R. International Series 146, 1982, pp. 171-176, Oxford, and also The History of the Countryside, 1986, pp. 141-144, Dent). The northern part, in the parish of Abbots Leigh, now a coppice-wood dominated by **Tilia cordata**, with **Quercus petraea**, **Q. robur**, ash and hazel, and containing such species as wild service tree and lily-of-the-valley, is believed directly derived from the prehistoric wildwood which was probably of lime with hazel and **Q. petraea**. The southern part, in Long Ashton parish, including Stokeleigh Camp and Nightingale Valley, contains three categories of trees. These are old coppice stools of lime, mainly on cliff ledges; pollarded trees, chiefly **Q. robur**, estimated as 200-400 years old; and maiden trees of ash and wych-elm not older than the mid-nineteenth century. The coppiced trees here, where there were rights of pasture in the twelfth century, were probably largely destroyed by grazing (except in inaccessible places), and the lime replaced mostly by the unpalatable **Q. robur**. Coppicing was probably abandoned, not later than the sixteenth century, in favour of pollarding. With grazing suppressed in the nineteenth century, young trees developing in the grassland and around the pollards were mainly ash and wych-elm. More recently the wych-elms have succumbed to Dutch Elm disease (although elm coppice shoots survive) and there is now serious invasion by sycamore. Leigh Woods also figure strongly in a series of Reports of the University of Bristol Avon Gorge Project, supported by the Arnold Foundation and others, by S.D. Micklewright et al. (see BSBI Abstracts, Part 18, p.14, July 1988). Surveys, population counts and trends are given, together with many recommendations for nature conservation (see the paper by C.M. Lovatt in this issue, pp. 8-9, which deals in some detail with the historical botany of Leigh Woods).

In a paper entitled 'Losses and threatened losses from the Somerset flora' (Proceedings of the Somerset Archaeological and Natural History Society for 1985/86, Vol. 130, pp. 193-199) Captain R.G.B. Roe reviews the changes in plant distribution in the county over the last 200 years. In particular, comparison of present-day records with those given in Rev. R.P. Murray's The Flora of Somerset, 1896, shows that 41 species included by Murray are no longer known in the county. Since the 1790's some 72 species appear to have been lost, the rate of extinction being twice as great this century as last, reflecting the increased effect of man's activities on the environment. Habitat destruction, drainage, changes in agricultural practices and the use of herbicides have all contributed to the accelerating decline; active conservation is a pressing priority.

Although new records of native plants are rather few for 1987, some notable finds were made. Of particular interest are the reports of **Lathyrus aphaca** and of **Centaurium pulchellum** on Mendip; neither species is common in the Bristol area and no records for these species on Mendip have been made for many years. The re-finding of **Hornungia petraea** in a site near Witham, last known here more than 70 years ago, is yet another example showing the high powers of persistence which some plants have. The continued spread of **Lactuca virosa** is a notable feature, many new stations being reported for this plant in 1987 in the Bristol area. Observations on hybrids give interesting and some new records in the genera **Rosa, Crataegus** and **Reynoutria**. After a run of rather poor years, the Avonmouth Docks yielded a rich harvest of alien species in 1987. Of particular note is the abundance of **Sida spinosa** and **Anoda cristata** var. **brachyantha**, plentiful **Chenopodium pratericola** (last recorded almost fifty years ago), the grass **Beckmannia syzigachne** and no fewer than ten species of **Amaranthus**, of which **A. tricolor** and **A. viridis** are new to the Bristol area.

Dr T.E.T. Bond, who had been a member of the Society since 1951, died on 17 December 1987. After working in Sri Lanka, he taught at the University of Bristol at Bracken Hill for a number of years and subsequently was adviser to overseas postgraduates at Long Ashton Research Station. He was President of the

Botanical Section of the Society from 1965 to 1969 and also served on the Library Committee. He led many fungus forays, contributed records of flowering plants and helped members with identifications. Also much missed will be Miss Elizabeth Lenton and Mrs Winifred Cummins, both of whom died on Christmas Day. Both were members of the Society for many years and contributed records. Miss Lenton's interest was mainly in the Mammal Section. She was particularly interested in the otter on which she carried out important conservation studies. Mrs Cummins gave long service to the Botanical Section Committee; also, together with her husband, she ran well-planned meetings for the Society and, in earlier years, assisted the late I.W. Evans with the wild flower display in the City Museum.

Names of contributors associated with several records or with the determination of specimens are abbreviated thus:

JA	J. Aldridge	CK	Mrs C. Kitchen
JMB	J.M. Boyd	MARK	M.A.R. Kitchen
RSC	R.S. Cropper	PJMN	P.J.M. Nethercott
GGG	Rev. G.G. Graham	BP	Miss B. Price
IFG	Miss I.F. Gravestock	RDR	R.D. Randall
IG	I. Green	RGBR	Capt. R.G.B. Roe, R.N.
PG	P. Green	MAS	Mrs M.A. Silcocks
ALG	A.L. Grenfell	MAW	M.A. Wilkinson
RAJ	R.A. Janes		

G: Gloucestershire S: Somerset

For details of the area covered by this Report, see 'Bristol Botany in 1978', p.35.

Equisetum sylvaticum L. In 1985, Compton Common, Compton Dando, S, M.W.J. Paskin.

Cystopteris fragilis (L.) Bernh. Several places on wall of farm, Cowhill, near Oldbury-on-Severn, G, CK and MARK.

Ranunculus sardous Crantz Rough pathway, Kingsweston old tip, Bristol, G, IFG.

R. lingua L. A detailed study of the performance of this plant in 1986 and 1987 in the Gordano Valley, where it was reported last year, has shown its presence in three small areas of Clapton Moor, and also a small patch in the adjoining Caswell Moor, S, Mrs S. Wilson. The plant appears to be grazed, but spreads by stolons which sometimes may be seen in the water of the rhines.

Nymphaea alba L. In 1986, in the River Chew at Keynsham, S, BP.

Fumaria densiflora DC. Flourishing at its site at Bromley Heath, Downend, G, ALG.

Hornungia petraea (L.) Reichenb. Re-discovered on garden wall, Millards Hill, north of Witham Friary, S, where first known about 1910 (see E.S. Marshall, A Supplement to the Flora of Somerset, 1914, p.21) and subsequently thought to have been lost, Mrs G. Read.

Cochlearia danica L. By main road, Keynsham, S, T. Rice et al. This plant is spreading as a result of the salting of roads.

Cardamine impatiens L. Ball Wood, Congresbury, S, RSC.

Scleranthus annuus L. Abundant over a much larger area than originally recorded on Bury Hill, Moorend, Winterbourne Down, G, ALG. Especially luxuriant in lush herbage frequently trodden by cattle, with much **Gnaphalium uliginosum** L. which has spread far from where previously known on the camp.

Chenopodium ficifolium Sm. Wayside, Lawrence Weston, G, ALG. Also, with **C. bonus-henricus** L. and **C. polyspermum** L., on Horfield Common, G, IFG, conf. Bristol Regional Environment Records Centre.

Halimione portaculoides (L.) Aellen Sand Bay, Kewstoke, S, RDR.

Geranium rotundifolium L. A single plant on wall of farm, Cowhill, near Oldbury-on-Severn, G, CK and MARK.

G. molle L. var. **aequale** Bab. Sea Mills, Bristol, G, IFG.

Genista tinctoria L. In small quantity, Lower Stone, G, CK and MARK.

Medicago arabica (L.) Huds. In two places at Cowhill, G, and abundant at Newlands Gout, Oldbury-on-Severn, G, CK and MARK.

Vicia bithynica (L.) L. In 1986, hedge of meadow, Upper Littleton, near Winford, S, RAJ.

Lathyrus aphaca L. Hedgerow of field, Cheddar, S, JMB. This vetchling is rarely recorded on Mendip.

Filipendula vulgaris Moench A large patch in **Bromus erectus** grassland, Tytherington Down, G, CK and MARK.

Rubus conjungens (Bab.) W.C.R. Wats. Walton Moor, Gordano, S, RDR, conf. A. Newton.

R. rudis Weihe & Nees Hunstrete Plantation, S, RDR, conf. A. Newton.

Aphanes microcarpa (Boiss. & Reut.) Rothm. Old spoil heap, Keynsham, S, RAJ and RDR.

Sanguisorba officinalis L. Abundant on site now being used as a tip, with **Serratula tinctoria** L., **Achillea ptarmica** L. and **Reynoutria japonica** Houtt., Gypsies Acre, Tytherington, G, CK, MARK and ALG.

Rosa arvensis Huds. x **R. rubiginosa** L. Two bushes by road, Damery Bridge, G, CK and MARK, det. GGG. **R. micrantha** Sm. was recorded from this site by C. Bucknall (see J.W. White The Flora of Bristol, 1912, p.293) but could not be found here in 1987 and may have been mis-determined, hybridity not being suspected.

R. dumetorum Thuill. In hedge flanking East Dundry Lane under Maes Knoll towards Whitchurch, S, PJMN.

R. canina L. x **R. stylosa** Desv. (**R.** x **rufescens** W.-Dod) Tait's Hill, Stinchcombe, G, CK and MARK, det. GGG.

R. canina L. x **R. afzeliana** Fr. Tait's Hill, Stinchcombe, G, CK and MARK, conf. GGG. This hybrid has not been recorded previously in the Bristol area. Rev. G.G. Graham notes (in litt.) that there are thousands of bushes of **afzeliana** x **canina**, probably more **afzeliana** (female) x **canina** (male) in the north and more **canina** (female) x **afzeliana** (male) in the south of Britain.

R. rubiginosa L. A bush at base of old railway spoil heap, Radstock, S, D.E. Green.

Crataegus laevigata (Poir.) DC. A single tree, rear of salt marsh, Berkeley; single mature tree in hedge, Tait's Hill, Stinchcombe; old tree in hedge, Little Heath, Breadstone, all G, CK, MARK and MAW.

C. laevigata (Poir.) DC. x **C. monogyna** Jacq. (**C.** x **media** Bechst.) With both parents in hedge, Tait's Hill, Stinchcombe; Lower Stone; and Sundayshill, near Rockhampton, all G, CK, MARK and MAW. Also in hedge, between bushes of the parents, Weston-super-Mare, S, RSC.

Sorbus torminalis (L.) Crantz Many trees in woods, Lower Stone and several fruiting in hedge nearby; three trees at Rockhampton; a single tree, Tortworth Lake; also frequent in Heneage Court Wood, Falfield, all G, CK and MARK.

Viscum album L. On large sycamore on the Village Green, Rockhampton, G, CK and MARK.

Myrrhis odorata (L.) Scop. Now gone from the motorway (M4) verge at Bromley Heath, Downend, G, ALG, where known since 1975. Its garden origin there seems more probable than introduction by traffic as earlier suggested.

Oenanthe pimpinelloides L. In small quantity, Sundayshill, near Rockhampton, G, CK and MARK. Much more widespread than previously realized on Mercia Mudstone (Keuper Marl) at St. Werburgh's, Bristol, G, ALG. This rather local umbellifer, characteristic of the Trias, occurs on both embankments of the ex-G.W.R. line to Clifton Down and Severn Beach and on adjacent land isolated by the South Wales line to the east and the former L.M.S. and G.W.R. joint line (now closed) from Kingswood Junction to Clifton Down.

Euphorbia paralias L. A single plant, on coarse sand brought in to build sea defences at shore line, Sand Bay, Kewstoke, S, MAS.

Polygonum rurivagum Jordan ex Boreau On dumped soil, Saltford, S, RDR.

Rumex pulcher L. With **Medicago arabica** (L.) Huds., Cromhall, G, CK and MARK.

R. palustris Sm. Dune marsh, Berrow, S, PG. Not recorded at this site since 1906.

R. maritimus L. About twenty plants in cattle-poached pond, Upper Hill, G, CK and MARK, near the colony previously reported ('Bristol Botany in 1984', p.66) which appears to have been overgrown.

Salix triandra L. On bank of stream, Morton, near Thornbury, G, CK and MARK.

S. repens L. Boggy springhead, Chelwood, S, RGBR.

Primula veris L. x **P. vulgaris** Huds. With parents, a single plant on disturbed ground, Stoke Bishop, Bristol, G, IFG and MAS.

Centaurium pulchellum (Sw.) Druce Fry's Hill, Axbridge, S, RSC. This is the first record on the Carboniferous Limestone since 1915.

Lithospermum arvense L. Disturbed ground, Chilton Polden Moor, S, RSC.

Cuscuta europaea L. Small colonies on stinging nettles in seven sites on the north bank of the Avon from Keynsham to Swineford, and abundant in one area near Swineford, G, CK and MARK. The remains of the plants from the previous year were easily seen in February on old stems of nettle.

Orobanche hederae Duby In quantity in herbaceous border, garden, Stapleton, G, and on roadside towards Frenchay, G, ALG, a mile distant.

Stachys x **ambigua** Sm. (**S. palustris** L. x **S. sylvatica** L.) In 1986, with neither parent in the immediate vicinity, roadside verge, Buckover, G; also, in 1987, with **S. sylvatica**, roadside ditch (**S. palustris** some half mile away), Kington, near Thornbury, G, CK and MARK.

Galeopsis angustifolia Ehrh. ex Hoffm. In 1985, near Queen Charlton, S, JA.

Legousia hybrida (L.) Delarb. Cornfield, Corston, S, RDR.

Serratula tinctoria L. In good quantity, with **Achillea ptarmica** L., Lower Stone, G, CK and MARK.

Lactuca virosa L. The striking spread of this species continued in 1987 with new records from Hambrook Common (in a garden) and Frenchay, G, and Eastville, St. Werburgh's, St. Philips and St. George, all Bristol, G, ALG. Another separate very large population was on a roadside at Crew's Hole, St. George, Bristol, G, surviving early verge-cutting and forming copious secondary growth; also on rocks near Observatory Hill, Clifton Down, G, ALG, and on limestone grassland opposite Clifton Zoological Gardens, G, Dr C.M. Lovatt. Further records are for Brislington and Arno's Vale, S, ALG, and timberyard, Bathampton S, R. Colston, conf. RDR. **L. virosa** is more robust than the similar **L. serriola** L. and typically larger in all its parts; the midribs of the leaves are less prickly than in **L. serriola** and its achenes are black and minutely rugose, whereas in **L. serriola** they range through greyish-green to light red-brown (ALG is mapping **L. virosa** in the Bristol area and welcomes records).

Crepis biennis L. Persists near Queen Charlton, S, JA.

C. capillaris (L.) Wallr. var. **glandulosa** Druce Rough pasture, Stoke Bishop, Bristol, G, IFG.

Butomus umbellatus L. In 1986, in River Chew, Keynsham, S, BP.

Convallaria majalis L. With **Polygonatum odoratum** (Mill.) Druce, still in Westridge Wood, Wotton-under-Edge, G, MARK and MAW.

Gagea lutea (L.) Ker-Gawl. Wood, Litton, S, RSC.

Ornithogalum umbellatum L. Abundantly naturalised in churchyard, Cowhill, G, CK and MARK.

Juncus compressus Jacq. With **Carex spicata** Huds., marsh, Stoke Bishop, Bristol, G, IFG.

Allium oleraceum L. By the towpath, Avon Gorge, S, IG, conf. ALG.

Iris foetidissima L. Plentiful in secondary ash woodland, near the river, Sheperdine, G, CK and MARK.

Epipactis helleborine (L.) Crantz A single plant, Titters Hill Wood, Littleton-on-Severn, G, CK and MARK.

Platanthera chlorantha (Custer) Reichenb. Five plants in woodland, Rockhampton, G, CK and MARK.

Ophrys x pietzschii Kümpel This hybrid between the Bee and Fly Orchids persists in Leigh Woods, Bristol, S, Dr T.C.E. Wells, where first known in 1968.

Lemna polyrhiza L. With **L. gibba** L., Newlands Gout, Oldbury-on-Severn, G, CK and MARK.

Scirpus sylvaticus L. Abundant, with **Equisetum telmateia** Ehrh. and **Stellaria alsine** Grimm, in marshy area, Tait's Hill, Stinchcombe, G, CK and MARK.

Carex humilis Leyss. A third colony, Cross Plain, near Axbridge, S, PJMN. This is rather larger than the two colonies reported in 'Bristol Botany in 1985', p.58, and there are also three very tiny patches within two feet of the main patch.

Alopecurus bulbosus Gouan On lawn, Sheperdine, G, CK and MARK.

ALIENS. **Consolida ambigua** (L.) P.W. Ball & Heywood Disturbed ground, Kingsweston, Bristol, G, IFG.

Corydalis bulbosa (L.) DC. Local research by ALG shows that this rare taxon, first found in 1905 by Miss Cockle in a small open wood on Coal Measures at Coalpit Heath, G, was lost in the late 1920's when its site was destroyed by surface mining.

Raphanus sativus L. In 1985, on drove, Nailsea Moor, S, P. Rooney.

Rapistrum rugosum (L.) All. Verge of newly-constructed road, Avonmouth, G, IFG.

Barbarea intermedia Bor. Arable field, Keynsham, S, RAJ and RDR.

Matthiola longipetala (Vent.) DC. ssp. **bicornis** (Sibth. & Sm.) P.W. Ball Roadside, near Wells, S, PG.

Lychnis coronaria (L.) Desr. A small patch, foot of Tytherington Down, G, CK and MARK.

Geranium nodosum L. Established on roadside, Millards Hill, Witham, S, RGBR and Mrs I.G. Roe.

Impatiens capensis Meerb. Among reeds, Berrow, S, IG.

Genista hispanica L. Abundant at foot of cliff, Uphill, S, IFG.

Lathyrus tuberosus L. Still at Cheddar, S, where reported in 1954, JMB. Also still near Keynsham, S, where recorded in 1907, JA.

Aruncus dioicus (Walter) Fernald In 1985, waste ground, near River Trym, Sea Mills, Bristol, G, IFG. A first record for v.c. 34.

Poterium polygamum Waldst. & Kit. On railway embankment and in nearby enclosure, St. Werburgh's, Bristol, G, ALG. Formerly cultivated for fodder, this species has a long history in this area.

Cotoneaster franchetii Bois One bush, in old quarry, Uphill, S, PG.

Crataegus x **prunifolia** (Lam.) Pers. In hedgerow, bordering Golf Course, Shirehampton, Bristol, G, IFG, det. A.C. Titchen. A first record for this hybrid.

Pyrus pyraster Burgsd. Single trees, Rockhampton; Little Heath, Breadstone; Tytherington Down, all G, CK, MARK and MAW.

Oenothera erythrosepala Borbás Abundant in roadside cutting, Stapleton, G, ALG.

Smyrnium olusatrum L. Abundant on roadside between Elberton and Olveston, G, CK and MARK. Rare in this area.

Reynoutria japonica Houtt. x **R. sachalinensis** (Friedrich Schmidt Petrop.) Nakai By the towpath, Rownham, S, and at Belmont Hill, S, Dr A.C. Leslie, conf. J.P. Bailey.

Nepeta x **faassenii** Bergmans ex Stearn Stoke Lane, Stoke Bishop, G, IFG, det. ALG.

Doronicum pardalianches L. Two established patches in woodland margin, Tytherington Hill, G, CK and MARK.

Cicerbita macrophylla (Willd.) Wallr. Sports ground, Horfield, Bristol, G, IFG.

AVONMOUTH DOCKS. Several factors led to a remarkable assemblage of aliens at the docks, the best by far in over ten years of observation by ALG. Many of the species recorded in recent years were present in increased quantity where railway tracks had been lifted, especially **Crepis tectorum** L. **Caesalpinia spinosa** (Mol.) O. Kuntze, previously noted some ten years ago, was seen again close to its earlier site. Numerous plants of the N. American Goosefoot **Chenopodium pratericola** Rydb., last recorded in the Bristol area nearly fifty years ago under **C. leptophyllum**, had very probably grown from long-dormant seed and the presence of much **Setaria faberi** Hermm. suggests a longer history in the area for this taxon than its very recent records might indicate.

The handling of soya waste imports at the Charles Ford mill introduced a number of aliens new to the Adventive List. Seed blown from the mill and quays germinated in quantity on adjacent waste ground and railway tracks resulting in records of ten Amaranth species: **Amaranthus albus** L., **A. blitoides** S. Wats., **A. cruentus** Mansf., **A. hybridus** L., **A. palmeri** S. Wats., **A. quitensis** Kunth, **A. retroflexus** L., **A. spinosus** L., **A. tricolor** L. and **A. viridis** L. At least six plants of the N. American dioecious **A. palmeri** were noted, all but one male with racemes up to 300 mm. Both **A. tricolor** and **A. viridis** are new to Bristol.

Hundreds, or even thousands, of plants and seedlings of **Sida spinosa** L. were present here and on roadsides throughout the docks, the spinous seeds perhaps transported by lorry tyres. Both the **Sida** and malvaceous **Anoda cristata** (L.) Schlectend. var. **brachyantha** (Reichenb.) Hochr. are illustrated in B.S.B.I. News 47 (1987). Myriad seedlings and small plants of **Ipomoea purpurea** (L.) Roth and **I. lacunosa** L. were casualties of the first frosts, as were seedlings of a **Cassia**, possibly **C. occidentalis**, and many fine plants of the American Signal Grass **Brachiaria platyphylla** (Griseb.) Nash, only one specimen of which managed a solitary, partly opened, panicle. A single seedling of the tropical pea **Sesbania exaltata** (Raf.) Rydb. ex A.W. Hill defied efforts to grow it on as did the **Cassia**. Among these unusual plants a tall, robust alien form of **Polygonum lapathifolium** L. was conspicuous as also was native **Spergula arvensis** L., here introduced from N. America where it is a widely naturalised alien. Several of the above-mentioned sub-tropical species had only developed into seedlings by early autumn; the help of Mr C.G. Hanson in their collection and cultivation is acknowledged.

Elsewhere in the docks were two widely separated plants of the tropical grass **Eleusine indica** Gaertn., last recorded in 1930; perennial **Setaria geniculata** (L.) Beauv.; single plants of the handsome S. American **Solanum sisymbriifolium** Lam. and **S. rostratum** Dunal from Mexico; an established patch of the green-fruited **S. nitidibaccatum** Bitter; **Brassica juncea** (L.) Czern. & Coss.; **Ambrosia artemisiifolia** L.; **Panicum dichotomiflorum** Michx.; **Bromus inermis** Leyss. and **Lepidium densiflorum** Schrad., another N. American taxon last recorded in the late 1920's.

The discovery of the E. European grass **Beckmannia syzigachne** (Steud.) Fernald, at some distance from its previously known sites in the docks (where it is no longer found), was of considerable interest as it occurred over a large area of permanently wet ground - a situation similar to its native habitat and one in which it seems to thrive. It may have been naturalized here for a considerable time. This occurrence is more fully documented in B.S.B.I. News 47 (1987) where the taxonomy of the genus in Europe is discussed. This unusual grass is illustrated in B.S.B.I. News 29 (1981) and its occurrence as a grain alien in Britain is reviewed. All Avonmouth Docks records, G, ALG.

I thank everyone who has supplied records and helped with these, especially Mr P.J.M. Nethercott, Captain R.G.B. Roe and Mr A.L. Grenfell. I am indebted to Long Ashton Research Station for meteorological records.

THE AVON GORGE

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INTRODUCTION

The papers in this volume of the BNS Proceedings all centre around Bristol's most famous landmark and they bring together a variety of specialist views on the natural history of the Gorge, its geology, birds, plants, bugs and land use. In some respects the Gorge is revealed as being highly distinctive, in its origin for example and in its function as a natural corridor for migration and colonisation, although for other forms of wildlife it is not a specially distinctive area. It is the past function of the Gorge simultaneously as a barrier to the spread of urban Bristol yet as a lifeline to Bristol's maritime economy that has shaped it as a habitat and provides the key to its modern natural history.

Small wonder then that most papers in this collection, because they take a detailed look at the way in which the present ecological landscape has evolved, demonstrate that it is only by an adequate study of the past that an understanding of the present is possible - the formation of the Gorge, the quarrying of its sides, the role of past boundaries in explaining differences in land use, changes in bird populations in sympathy with human development and practice, and so on.

The papers are not without controversy and there are conspicuous differences of view over, for example, the relative importance of the Pleistocene ice sheets in the formation of the Gorge, even though there is now no doubt that the ice margin lapped around the Bristol region during at least one of the major Pleistocene episodes. Another example would be a difference of view over the form that present conservation measures should take and whether current practice is wise or not, recognising that what is beneficial for one type of wildlife can be inimical to another. What is inescapable is that, with now over half a million people living on the doorstep, the natural history of the Gorge is and has always been in the most delicate balance between its human and non-human populations, never more than now.

This issue represents a cross-section and a flavour of the kind of work which Avon naturalists are engaged upon; it cannot be exhaustive and, because survey work goes on all the time, new findings will become available which will justify a return to the Gorge theme at some time in the future. For the moment however, this volume offers a great deal which is of interest to the naturalist about a spectacular landscape feature, synonymous with the City of Bristol, which surely deserves our closest study.

ALLAN E. FREY, **Hon. Editor**

Further reading: Details of other papers published by Bristol Naturalists' Society relating to the natural history of the Avon Gorge may be found on Page 20.

Proceedings of the Bristol Naturalists' Society (1987), **47**: 3-19

THE HISTORICAL ECOLOGY OF LEIGH WOODS, BRISTOL

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ABSTRACT

Leigh Woods lie on the west side of the Avon Gorge, Bristol, and have been a familiar sight to generations of Bristolians. The woods are crossed by the parish boundary between Long Ashton to the south and Abbots Leigh to the north. The woods of the southern parish, which include the Iron Age hill fort Stokeleigh Camp, had a long history of grazing as well as woodmanship. They are now owned by The National Trust and managed by the Nature Conservancy Council. The northern parish includes the ancient Leigh Wood and its management is divided between the Nature Conservancy Council and the Forestry Commission.

The results of archival research and field work by the present author and others are combined to give an account of the historical ecology of Leigh Woods, illustrated by a map on pages 8 and 9 which shows most of the places mentioned in the text.

INTRODUCTION

Leigh Woods lie only a few kilometres to the west of the centre of the City of Bristol. They occupy some 190 hectares beside and above the River Avon and, together with Clifton and Durdham Downs opposite, form an integral part of the Avon Gorge, a site whose reputation has hitherto principally rested upon the variety of its flora and the concentration of rare plants there. White (1912) described the Avon Gorge as a "botanical Mecca" while, more recently, Rackham (1982) has described the Avon Gorge as "a place of exceptional interest for the archaeology of vegetation".

In his PhD Thesis, the writer considered in some detail aspects of the historical ecology of the grasslands and herbaceous vegetation of the slopes of the Avon Gorge (Lovatt, 1982) but it was Rackham (1982, 1986), introduced to Leigh Woods by the present author in 1979, who first interpreted and reported on the woodlands. The present paper incorporates additional research and presents new findings about the history of specific parts of the woods.

Throughout the paper, the term Leigh Woods (in the plural) is used for the whole of the continuous area of woodland which includes parts in the parishes of Abbots Leigh to the north and Long Ashton to the south. At present the Nature Conservancy Council (NCC) manage the woods of Long Ashton and parts of those of Abbots Leigh as the Avon Gorge National Nature Reserve (NNR) of just over 60 hectares. The NCC also oversee the northern quarries and hanging woods, some nine hectares. The remaining 120 hectares in Abbots Leigh are occupied by the Forestry Commission and are now managed for commercial timber production with special consideration being given to nature conservation.

LEIGH WOODS IN THE EYES OF BRISTOLIANS

The natural beauty of Leigh Woods in their Gorge setting has long been recognised by Bristolians and recorded by writers and artists. Manby (1806) described the view from Sea Walls as "thickly clothed from top to bottom with an exuberant mantle of wood, but allowing the frequent appearance of the face of rock or ledges of quarry" adding, "the view down the river for some distance continues in fine hanging woods, breaking into forms pleasingly irregular".

Early 19th Century paintings of the Bristol School of Artists (Greenacre, 1973; Gill, 1973; Greenacre & Stoddard, 1986), several of which are on permanent display in the Bristol City Museum and Art Gallery, show a considerable contrast between the form of the vegetation on the two sides of the river, one wooded and the other sheep-grazed turf with trees first appearing in quantity at Cook's Folly Wood. The same effect is seen in an aerial panorama of Bristol from the south, published in 1887 (frontispiece in Lovatt, 1982, and on display as above). The contrast has now been lessened by the development of secondary woodland on the slopes of the Downs following the cessation of grazing.

In his Flora of Bristol, White (1912) wrote of "famed Leigh Woods, a fine forest-like tract that crowns the cliffs and descends to the tideway", continuing, "these woods are the home of a plant community of uncommon interest. They contain nearly every indigenous tree in the country, and offer in consequence a foliage of singularly varied tint, from that of the darkest Yew to the pale light green of Lime and Oak, or silver of the Whitebeam". White also commented on the quarrying, lamenting the "huge and hideous quarries opened on the Leigh side, with a consequent destruction of the exquisite hanging woods". Contemporary postcards and photographs reveal the harsh industrial scene described by White, but now softened through natural revegetation: in 1935 M. Wills purchased the last working quarry below Leigh Woods ("Quarry 2", opposite the Gully).

THE RARE PLANTS

Despite the greater repute of the Clifton side of the Avon Gorge, the Leigh Woods side is no less rich in rare species, but of those twelve that find mention in the Red Data Book (Perring & Farrell, 1983) only one is essentially a woodland plant. Large-leaved lime (**Tilia platyphyllos**) is a relatively recent discovery by P.J.M. Nethercott and is confined to a very small area of the woods.

Leigh Woods are probably best known to field botanists at present as the site of at least eleven different types of **Sorbus**. Two, the Bristol whitebeam and Wilmott's whitebeam, are endemic to the Avon Gorge but, along with the other nationally rare **Sorbus** species found at Bristol, they are light-demanding cliff-edge trees which have in the present century colonised the abandoned quarries. In contrast to the grasslands, a study of the rare plants of the Avon Gorge has little direct relevance to the historical ecology of the woodlands.

ANCIENT WOODLAND INDICATOR SPECIES

The witness of Bristolians has demonstrated that Leigh Woods have been wooded throughout the last two centuries. However, an ancient woodland is defined as one which has had a continuous history as such since at least 1600; many of these woods probably have a direct continuity with the post-glacial 'wildwood' (Peterken, 1981). Peterken found 34 plant species with a strong affinity for proven ancient woodlands in Central Lincolnshire. No less than 29 have been recorded as natives in Leigh Woods although some, like the bluebell, can thrive outside woods in the more oceanic climate of the south-west: lists of ancient woodland indicator species are properly of regional application only, but no local list has been researched and disseminated.

Table 1 below records the distribution, in three parts of Leigh Woods, of 12 species selected from the tentative list of 120 indicator plants used by the NCC

ENGLISH NAME	SCIENTIFIC NAME	AREA OF OCCURRENCE		
		1	2	3
Nettle-leaved Bellflower	**Campanula trachelium**	+	.	.
Small-leaved Lime	**Tilia cordata**	+	+	+
Wood Anemone	**Anemone nemorosa**	.	+	+
Columbine	**Aquilegia vulgaris**	.	+	+
Lily-of-the-Valley	**Convallaria majalis**	.	+	+
Great Wood-rush	**Luzula sylvatica**	.	+	+
Sessile Oak	**Quercus petraea**	.	+	+
Wild Service-tree	**Sorbus torminalis**	.	+	+
Pale Sedge	**Carex pallescens**	.	.	+
Wood Millet	**Milium effusum**	.	.	+
Early-purple Orchid	**Orchis mascula**	.	.	+
Wood Vetch	**Vicia sylvatica**	.	.	+
TOTAL NUMBER OF INDICATOR SPECIES		2	7	11

The three areas into which Leigh Woods is divided in this analysis, and their respective sizes are:

1. The National Nature Reserve : Long Ashton Parish (37 hectares)
2. The National Nature Reserve : Abbots Leigh Parish (25 hectares)
3a. The Forestry Commission Holding : Abbots Leigh Parish (120 hectares)
b. The Northern Quarries : Abbots Leigh Parish (9 hectares)

English names follow Dony, Perring and Rob (1980) and scientific names follow Clapham, Tutin and Warburg (1981). In the text, English names are used throughout, with the scientific name being given after the first mention of the plant.

TABLE 1 Some Ancient Woodland Indicator Plants and their Occurrence in Leigh Woods, Bristol.

in their ancient woodland survey of their South Region (Leigh Woods lies in their South West Region). Only sessile oak (**Quercus petraea**) is not also included in Peterken's Central Lincolnshire list, although it occurs in 'old woods and hedges' in the county (Gibbons, 1975).

The table demonstrates the increasing diversity of ancient woodland indicator plants found towards the north of Leigh Woods and this is paralleled by the increasing abundance of one of the species, small-leaved lime (**Tilia cordata**). In the Forestry Commission holding, extensive areas of former lime coppice survive, as mapped and surveyed by Micklewright (1988). Notable areas are near the car park, between the northern quarries (an area known as Lily Point owing to the presence of lily-of-the-valley there) and in Paradise Bottom. In the southern part of the NNR, other than in small but significant areas of the slopes below Stokeleigh Camp, only isolated trees occur either as pollards, such as near Stokeleigh Camp, or as coppice stools on inaccessible cliff edges in Nightingale Valley.

Similar analyses can be performed for other groups of organisms. Randolph (1987) cited the unpublished hoverfly records of R.H. Poulding in Leigh Woods. Amongst the 64 species recorded there, seven were on a list of primary (i.e. ancient) woodland indicator species. This compares with five for the smaller Hayley Wood in Cambridgeshire and 13 for the better documented Monks Wood in Huntingdonshire. Both of these woods are ancient and have detailed published accounts (Rackham, 1975; Steele & Welch, 1973).

THE PARISH BOUNDARY WALL

Rackham (1976) has emphasised the importance of the study of boundaries, both internal and external, in the investigation of woodlands. An illustrated report by the present author on the boundaries of Leigh Woods is in preparation for the University of Bristol Avon Gorge Project and some of the findings are presented in this paper. There are about five kilometres of stone walls in various states of repair within the present confines of the woods. The parish boundary wall is the best known. It was probably built in 1813, when Parliament passed an Enclosure Act for Long Ashton, for it includes a yew tree mentioned in the parish perambulation of 1799 (Way, 1913) and the wall is shown on the First Edition Ordnance Survey map published in 1830.

Standing in the NNR where this wall begins to descend to the river and looking northwards, one sees oak-hazel woodland in the form of coppice-with-standards, generally regarded as the typical form of old English woodland. In such woods the oak (here sessile oak) standards were allowed to grow as timber for ships or buildings and the hazel would have been coppiced on a cycle of approximately ten years to provide firewood and poles for fencing.

To the south of the boundary wall, the old trees of the NNR are mostly pollards, usually of pedunculate oak, (**Quercus robur**). These are from 200-400 years old but many are now dead. They have not been pollarded during the present century. The younger trees, none over 150 years old, were mainly ash (**Fraxinus excelsior**) and wych elm (**Ulmus glabra**), although this latter species succumbed to Dutch Elm disease after 1976 and extensive fellings became necessary.

Visiting the site with the writer in 1979, Dr Rackham was able to discern the dual nature of Leigh Woods. The northern woodland is ancient but the southern part is largely redundant wood-pasture, in which the two apparently conflicting forms of management co-existed. The remainder of this paper follows the prehistory and history of the two Leigh Woods, differentiated as we have seen by species content, woodland structure and parish, and rests heavily on the insight and interpretation of Dr Rackham (1982, 1986). Except where otherwise indicated, the historical quotations are from Way (1913).

THE PREHISTORY OF LEIGH WOODS

The wildwood which developed in the 5000 years between the retreat of the glaciers from north of Bristol and the agricultural and pastoral activities of Neolithic man was undoubtedly varied, but cannot explain the present distinction between the two parts of Leigh Woods. The general form of the Leigh Woods of 7000 years ago can be interpreted from a pollen diagram from the nearby Gordano Valley (Jefferies **et al.**, 1968). For every six grains of oak pollen, three of hazel and one each of lime and elm occurred; ash, beech and hornbeam were unrecorded. Interpreted at the time as mixed-oak forest, the low pollen production by the insect-pollinated lime means that lime would in fact have been the most common tree.

With time, man increasingly used and so modified the wildwood for his changing needs. The Leigh Woods area is the major local site for Neolithic arrow and axeheads (Grinsell, 1969), indicating hunting, warfare, and the commencement of tree clearance.

The hillforts of Bower Walls Camp (now Burwalls) and Stokeleigh Camp were built on either side of Nightingale Valley in about 300 BC (Grinsell, 1969); Clifton Camp (now Observatory Hill) guarded the opposite side of the Avon. The place-name 'Stokeleigh' seems to commemorate the clearance of woodland at this date: 'Stoke' (i.e. 'stock') meaning the stumps of recently felled trees and 'Leigh' implying an inhabited clearing surrounded by woodland.

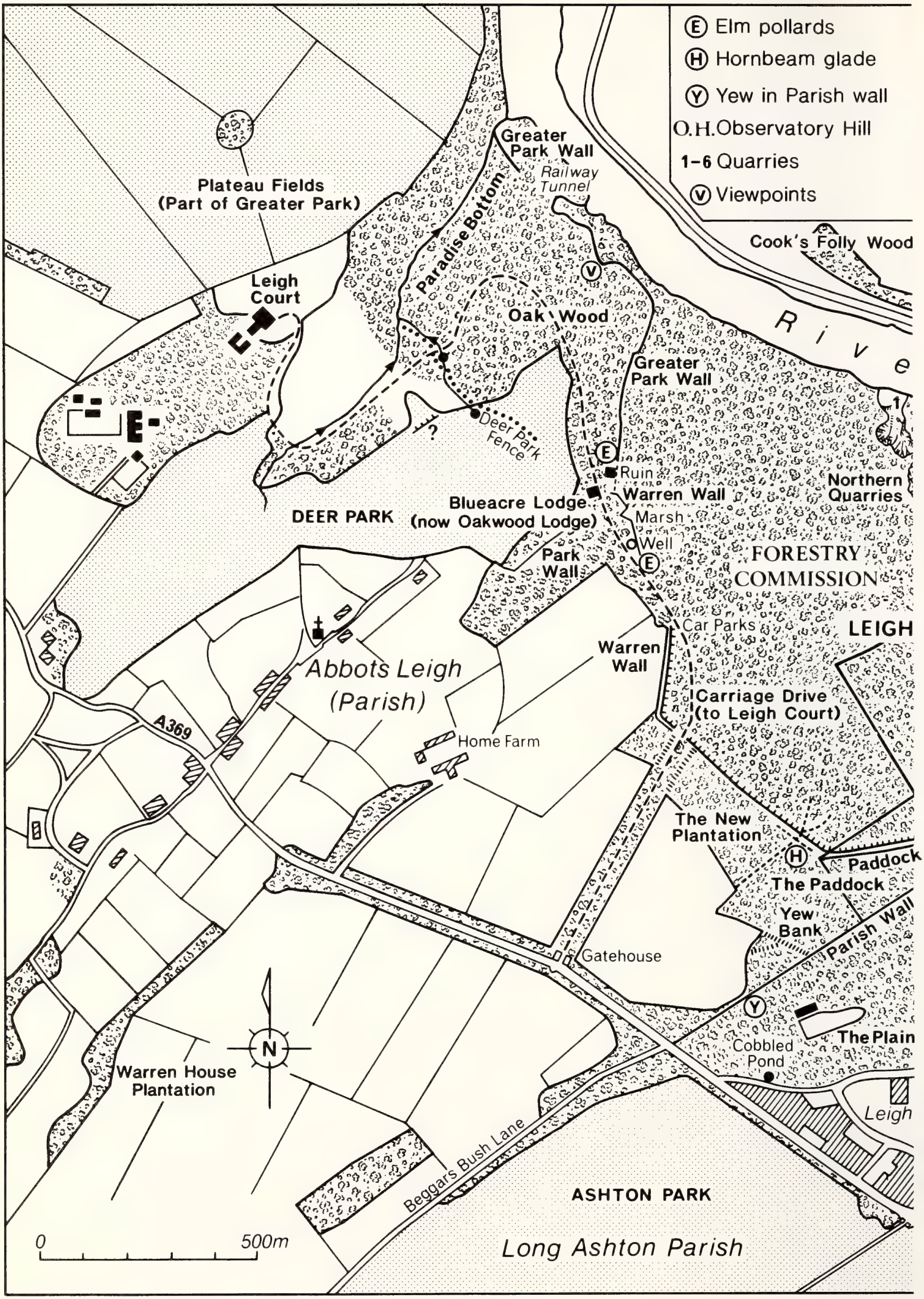
An examination of the documents that accompanied changes in the ownership of land from Mediæval times onward, often throws light upon the land use of Leigh Woods and it is to these that we now turn.

THE WOODS OF LONG ASHTON

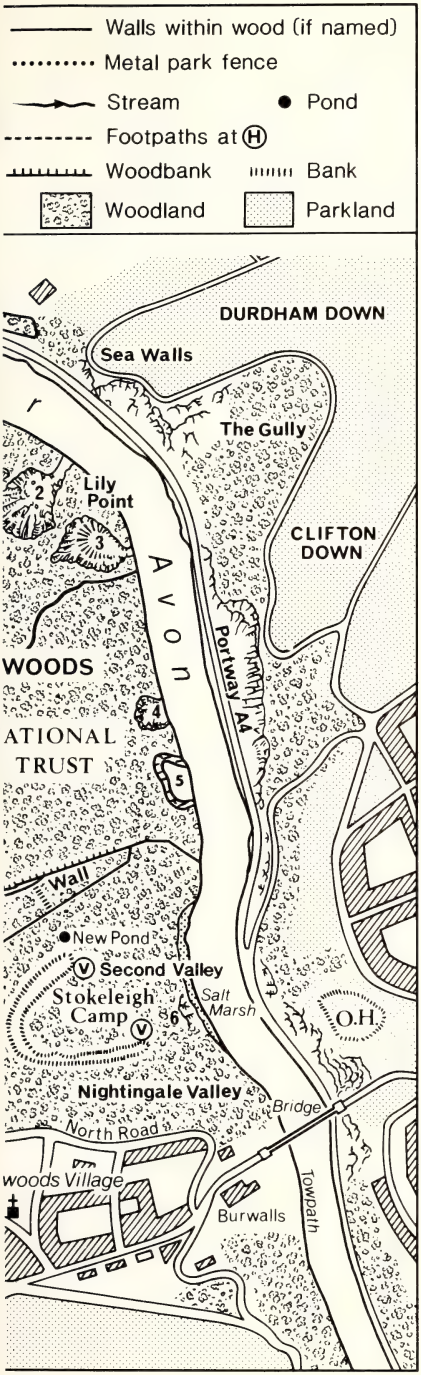
A Deed of 1331 shows that Leigh Woods were then divided between three owners. The slopes below Burwalls belonged to St. Katherine's Hospital of Bedminster and the northern part in the parish of Leigh (later Abbot's Leigh) was owned by St. Augustine's Abbey of Bristol. These two areas were described as woods, meaning productive coppice woods. The intervening land in Long Ashton, owned by the de Lyons family, was distinguished as "a common of pasture in a waste place containing two hundred acres with woods" and was bounded by the aforementioned woodlands, the River Avon to the east and Leigh and Ashton Downs to the west. Within the 200 acres lay Stokeleigh, Ludhull and Knyghtwode, confirming the multiple use.

By the 1331 Deed, St. Augustine's added these 200 acres to their northern holding, which they had acquired by exchange in 1193 from St. Mary's in Salisbury. Subsequent to this date, the greater part of Leigh Woods remained in their management for two centuries. In 1386-7 it is recorded that three woodsman were required to deal with the coppice and that sixteen boatloads were sent annually the four kilometres to the Abbey. Outside labour was used for the felling of timber for the Abbey dormitory (Sabin, 1960). Several hundred acres of coppice with riverside access are implied (cf. Rackham, 1975) and it may be presumed that most of this was in the parish of Leigh.

After the dissolution of the monasteries in the 1530s, Leigh Woods fell to Sir George Norton of Abbots Leigh. In 1568 a dispute arose between him and Hugh Smyth, the owner of the Long Ashton estate to the south, over land which lay between them. This land was described as "a parcell of waste grounde or soyle with all wooddes thereon growinge (coppice) or standing (timber) ... in Ashton ... between the woode of ... Sir George Norton called Lighe Woode on the north part and a place called Burwalls on the south part and strecheth to the Ryver of Aven on the east side and the Ashton doune and Lighe doune on the west side ...". The similarity to the earlier description of 1331 suggests a consistent management of the land by St. Augustine's Abbey. Identification of


Ⓔ Elm pollards
Ⓗ Hornbeam glade
Ⓨ Yew in Parish wall
O.H. Observatory Hill
1–6 Quarries
Ⓥ Viewpoints
Plateau Fields (Part of Greater Park)
Leigh Court
Paradise Bottom
Greater Park Wall
Railway Tunnel
Cook's Folly Wood
River
Oak Wood
Greater Park Wall
Deer Park Fence
?
DEER PARK
Blueacre Lodge (now Oakwood Lodge)
Ruin
Warren Wall
Marsh
Well
Northern Quarries
FORESTRY COMMISSION
LEIGH
Park Wall
Car Parks
Warren Wall
Abbots Leigh (Parish)
A369
Carriage Drive (to Leigh Court)
Home Farm
The New Plantation
Paddock
The Paddock
Yew Bank
Parish Wall
Gatehouse
The Plain
Cobbled Pond
Leigh
N
Warren House Plantation
Beggars Bush Lane
ASHTON PARK
Long Ashton Parish
0
500m

Reproduced from the 1921 1:10,560 Ordnance Survey map.


Walls within wood (if named)
Metal park fence
Stream
Pond
Footpaths at Ⓗ
Woodbank
Bank
Woodland
Parkland
DURDHAM DOWN
Sea Walls
r
The Gully
2
Lily Point
3
CLIFTON DOWN
Avon
Portway A4
WOODS
4
NATIONAL TRUST
5
Wall
New Pond
Ⓥ Second Valley
Stokeleigh Camp
Ⓥ
6
Salt Marsh
O.H.
Nightingale Valley
Bridge
North Road
woods Village
Burwalls
Towpath

THE HISTORICAL ECOLOGY OF LEIGH WOODS

The map shows the location of boundaries and other features mentioned in the text within the present-day woodland.

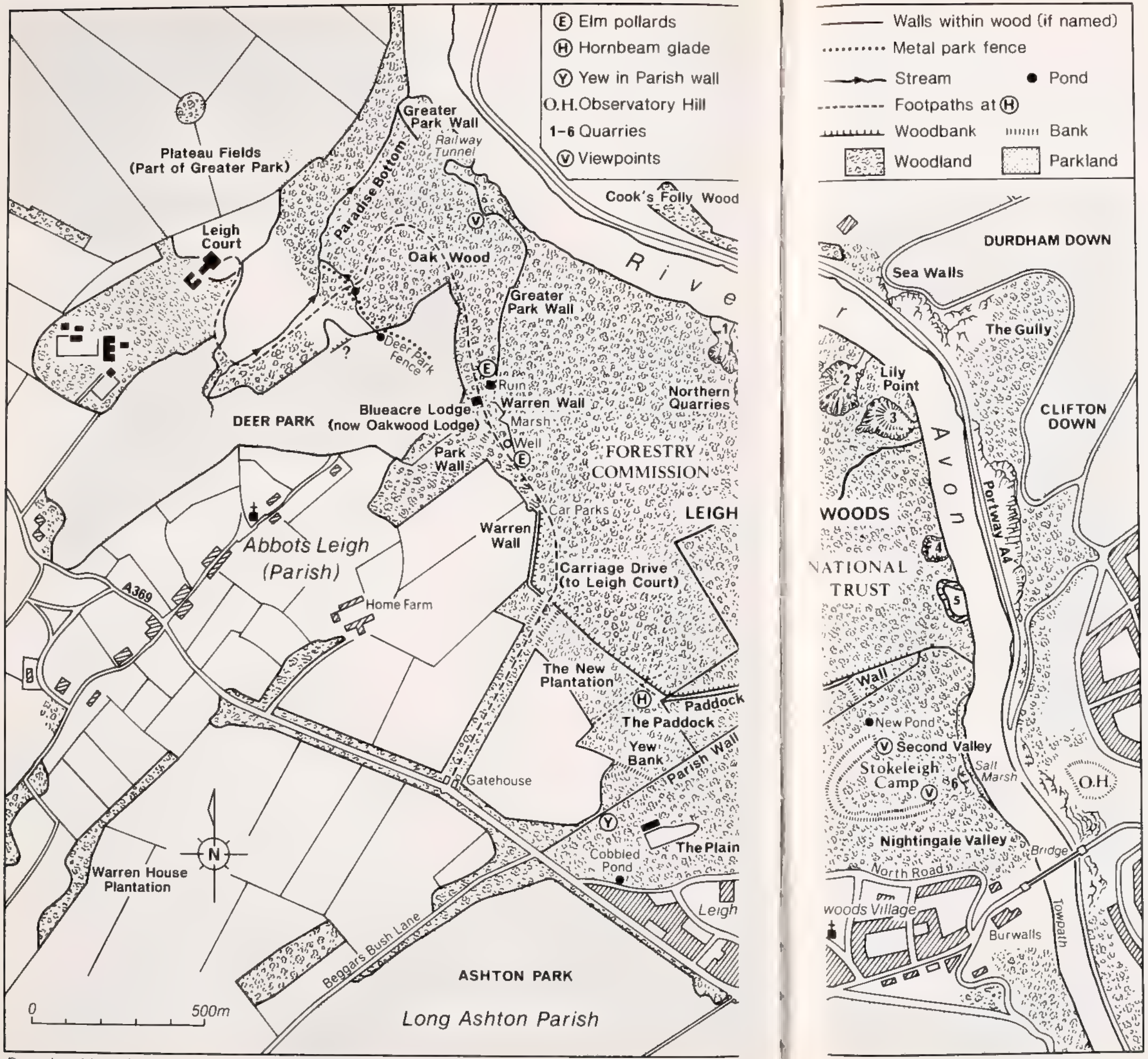
The woodbank marks the southern boundary of the ancient Leigh Wood. Other banks depicted are connected with 19th Century plantations.

The woodland extensions west of Leigh Court and Blueacre Lodge have no historical connection with the ancient Leigh Wood.

The map makes no attempt to distinguish woodland of different origin or type.

Features outside the woodland are drawn from the 1921 edition of the 1881-2 Ordnance Survey 6" : 1 mile map. These features remain relatively unaltered in outline although the deer park no longer functions as such. A clear distinction is visible between the large rectangular fields resulting from the early 19th Century enclosure of Leigh Down (latterly Leigh Warren) and the small irregular ancient fields at Abbots Leigh.

The map was prepared for publication by S. Godden from a hand-drawn version by the author.


Ⓔ Elm pollards
Ⓗ Hornbeam glade
Ⓨ Yew in Parish wall
O.H. Observatory Hill
1–6 Quarries
Ⓥ Viewpoints
Walls within wood (if named)
Metal park fence
Stream
● Pond
Footpaths at Ⓗ
Woodbank
Bank
Woodland
Parkland
Plateau Fields (Part of Greater Park)
Leigh Court
Greater Park Wall
Railway Tunnel
Paradise Bottom
Oak Wood
Cook's Folly Wood
River
Deer Park Fence
DEER PARK
Blueacre Lodge (now Oakwood Lodge)
Ruin
Warren Wall
Marsh
Well
Northern Quarries
FORESTRY COMMISSION
Park Wall
Car Parks
LEIGH WOODS
NATIONAL TRUST
Abbots Leigh (Parish)
A369
Home Farm
Warren Wall
Carriage Drive (to Leigh Court)
The New Plantation
Paddock
The Paddock
Yew Bank
Parish Wall
Gatehouse
Cobbled Pond
The Plain
Leigh
Warren House Plantation
N
Beggars Bush Lane
ASHTON PARK
Long Ashton Parish
0
500m
DURDHAM DOWN
Sea Walls
The Gully
Lily Point
CLIFTON DOWN
Avon
Portway A4
Wall
New Pond
Second Valley
Stokeleigh Camp
Salt Marsh
O.H.
Nightingale Valley
Bridge
North Road
Woods Village
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this piece of land is helped by the inclusion of two more place names, Ligheslade and Holmslade. Their present day location can (unlike Ludhull and Knyghtwode) be interpreted with reasonable certainty. A 'slade' is a valley, often a marshy one, and Ligheslade presumably later became Stokeleigh Slade, known since the 19th century as Nightingale Valley. 'Holm' refers to flat ground near a river and so Holmslade must have been the so-called second valley leading from the northern corner of Stokeleigh Camp to the one significant area of saltmarsh below Leigh Woods. The dispute over this "saide parcell of grounde and pasture" was resolved by the payment of a "certen sume of money" to Sir George Norton by Hugh Smyth whose title to it was thereby confirmed.

Later, in 1605, the Smyth family also added Burwalls to their Long Ashton estate, a parcel of land that was described in 1621 as eight acres of "pasture or woodey grounde" and is today 11 acres (4.5 hectares) of secondary woodland.

The Smyth family sold the woods in 1865 and disposed of much of their land in North Somerset in the early postwar period, culminating in the sale of Ashton Court and the surrounding Estate to Bristol Corporation in 1960.

In 1626 appears the first reference to quarrying when there was leased to a Clifton limeburner "one cottage ... and one Lyme Kill with all the quarres ... in the Slade under Stokley Wood between ... Rownham and the wood called Lye Wood with common of pasture for two ... beasts in the common thereto adjoyning saving all manner of trees woods and underwoods there uppon growing ...".

In 1655 permission was granted for the construction of a building for lead smelting below Burwalls, though it was not in fact built until about 1680. Called the Cupiloe, cast iron was also made there. Both lime burning and ore smelting would have utilised charcoal from the nearby coppices. D'Oyly (1975) reported that charcoal burning hearths could still be found within the NNR and Dr Rackham has also tentatively identified charcoal pits in the woods of the northern parish.

In 1667 a 21 year lease was granted to a Bristol baker, giving rights to coppice but, as usual, reserving timber. Coppicing produced faggots as fuel for the bread ovens and was to be carried out "only at seasonable times in the yeare". These were defined as between the quarter days of 29th September and 25th March, that is when the coppice was not actively growing, so that "ye same woods may be saved and preserved according to ye custome of ye country".

The lease referred to the site as "woodes, underwoodes and coppices now standing and groweing in and upon the Slade contayning one hundred acres be it more or less". The acreage suggests that not only Nightingale Valley but also the surrounding plateaux and the riverside slopes may have been included. An annual rent of £5 was payable whereas at the same time a similar area of Hayley Wood in Cambridgeshire was worth £50 annually (Rackham, 1975). Whilst the value must also have reflected quality, it seems likely that not all of the 100 acres bore coppice in traditional form.

Analysis of the account of the sale of wood and timber from Stokeleigh in 1788 likewise indicates low productivity and returns. Timber was sold for boats and coal pits; the coppice provided 5200 faggots of various types and quantities of posts and poles. 50 acres of coppice-with-standards could maintain this level of production. Sir J.H. Smyth received the posts and poles, £10 in cash and a similar value of faggots.

In the early 19th century the vicinity of Nightingale Valley became a fashionable resort, visited regularly by members of the scientific and artistic communities, as well as by the general public. By contrast, the wood of Abbots Leigh was less popular, presumably due to its greater distance from Clifton and its working nature. The lime tree was first recorded in Leigh Woods only in 1840 but, significantly and perceptively, Leo H. Grindon (1841) insisted on its native status, reporting that "on the craggy precipitous sides of Nightingale Valley are several fine specimens". (Dr Rackham made the same observation in 1979). A tea garden was established by the river below Burwalls and sketching parties were held in Nightingale Valley and nearby. One artist, the Reverend Eagles, compared Leigh Woods to the "regions of Elysium" (quoted in Greenacre, 1973). Accordingly, a great many detailed landscapes of this part of Leigh Woods can be studied.

Despite the general cover of trees, the slopes of Nightingale Valley were then grassy in places (plates 25 and 26, Greenacre & Stoddard, 1986). Four sheep and four rabbits are drawn on the Plain at the northern edge of the valley in 1831 (plate I/3.7, Lovatt, 1982). In nearby Ashton Meadows, cattle grazed the saltmarsh (p.9, Gill, 1973).

Coppice management is clearly inconsistent with the common rights of pasture that existed and the regrowth shoots of lime are particularly palatable. There are two possible general solutions to this problem. Firstly, there could have been maintained within the overall boundaries separate areas for grazing and for woodland management. If the divisions were not permanent, fencing could protect the coppice until the shoots became sufficiently woody and tall to offer protection from grazing. Seasonal grazing might also have applied, but there is as yet no evidence for the pannage of pigs in Leigh Woods.

A second solution permits permanent grazing beneath pollarded trees where production of wood (as opposed to timber) is continued by cutting above the level to which grazing stock can reach. Pollards are familiar at riversides or in hedges or fields and parkland: at greater density they form wood-pasture, a tradition of certain antiquity (Rackham, 1986). Epping Forest is an ancient wood-pasture where pollen analysis has shown that lime, now totally absent, gave way to oak in the mid Anglo-Saxon period.

The evidence suggests that the Long Ashton part of Leigh Woods was partly wood-pasture and partly a wood in which there was unenclosed grazing: hence palatable lime became increasingly confined to the crags of Nightingale Valley. Of the two oaks, pedunculate oak has lesser palatability and so would have replaced sessile oak. Pedunculate oak is therefore the commonest species amongst the pollards of Leigh Woods as well as being the commoner oak of the Bristol region. Depending on the density of the pollards and other factors, the ground layer could be grassland, scrub or heath, but in all cases the environment would cease to favour the herbaceous ancient woodland indicator species. The nettle-leaved bellflower, like the lime tree, is confined in Nightingale Valley to the crags.

The date of establishment of wood-pasture in Leigh Woods is not directly evident from the documentary record as it cannot unequivocably be distinguished from a woodland/pasture mosaic. The age of the present pollards indicates that wood-pasture existed in the 17th century and a painting by Eagles dated 1817 (catalogue No. 296, Greenacre, 1973) showing a recently pollarded tree indicates an earlier date. At its earliest mention the Long Ashton part of Leigh Woods was distinct: in 1331 it was "a common of pasture with woods" comprising 80 hectares in all and both pasture and wood are consistently referred to. The Tithe map and apportionment of 1842 (Somerset Record Office) separates, by a dotted rather than a firm line, 26 hectares of "wood and rock" centred on Stokeleigh Camp from the 28 hectares to the west which were described as "pasture". The present distribution of pollards is broadly similar and the pasture of 1842 was properly wood-pasture. It is possible that the same was true in 1331. Indeed, Rackham (1986) considered that much of the woodland of Norman England was in fact wood-pasture but that, by 1300, the area of these commons had greatly diminished.

The early 19th century surely represented the end of many centuries of relatively constant management, although the boundary of wood from wood-pasture would have always been unstable. In a watercolour of about 1830 (plate 25 in Greenacre & Stoddard, 1986) two old and repeatedly pollarded oaks lie uprooted near the top of Nightingale Valley. Neither lime nor sessile oak have great regenerative powers and so these species could not re-invade. Nor, withou grazing to assist it, could pedunculate oak successfully compete: palatable elm and ash and invasive but short-lived birch formed secondary woodland.

Many ash trees in both Nightingale Valley (plates 25 and 26 in Greenacre & Stoddard, 1986) and below (p.17 in Greenacre, 1973) show a distinctive narrowl Y-shaped trunk and appear to have been pollarded just once in about 1800 and then allowed to grow in a competitive situation such as would occur when grazin was reduced and trees were able to become established. One such ash of the appropriate age grew in the north-west corner of Stokeleigh Camp but had to be felled in about 1980 as it dangerously overhung the path.

The Leigh Woods pier of the Clifton Suspension Bridge was built between 1836 and 1840 and by 1842 potatoes were being cultivated in Stokeleigh Camp, the woods were hedged off and public access was restricted. Part of the woods were let as a rabbit warren and this continued until at least 1854. (This probably followed the enclosure of the nearby Leigh Warren, see below.) Large trees were felled throughout the woods of both parishes and quarrying was extensive.

In 1860 Sir Greville Smyth gave £2500 to ensure the completion of the Suspension Bridge and soon afterwards made an abortive attempt to sell 170 acres (69 hectares) of Leigh Woods to a land speculator who planned 800 buildings on the site. Eventually in 1865 it was sold to the Leigh Woods Land Company for £40000. The railway beneath Leigh Woods was commenced in 1863. Burwalls and the plateau south of Nightingale Valley were promptly developed. Many pollard oaks remain within the village of Leighwoods today, but all trace of the limestone heath has gone (Lovatt, 1982).

By 1909 it seemed probable that the remainder of the land would be built upon. Moved by the presence of the hillfort and the amenity value of the woods rather than any specific interest in their natural history (Baker, 1908-14), G.A. Wills, a local resident and one of the tobacco family, purchased the 32 hectares that remained and presented it to the recently-formed National Trust. The Committee of Management, which now includes the present author, has met annually ever since. Between 1933 and 1949 the Wills family made further gifts, including the 26 hectares in Abbots Leigh (D'Oyly, 1975).

The National Trust woods were used principally for amenity, though planting of non-indigenous trees such as larch, Scots pine, sycamore, beech and the excessively invasive Norway maple took place. The underwood west of Stokeleigh Camp was last cut in the 1930s (R.V. Russell, **pers. comm.**, 1978) and the Warden's Cottages were built in 1936. During the war a barrage balloon flew above the plain and a partial re-turfing subsequently proved necessary (D'Oyly, 1975). In 1970, European Conservation Year, this part of Leigh Woods became a National Nature Reserve, with an agreement between The National Trust and the Natural Environment Research Council (now vested in the Nature Conservancy Council) for conservation management supervised by a resident NCC warden. The NCC also leases and manages the three northern quarries and the lime-dominated slopes between them.

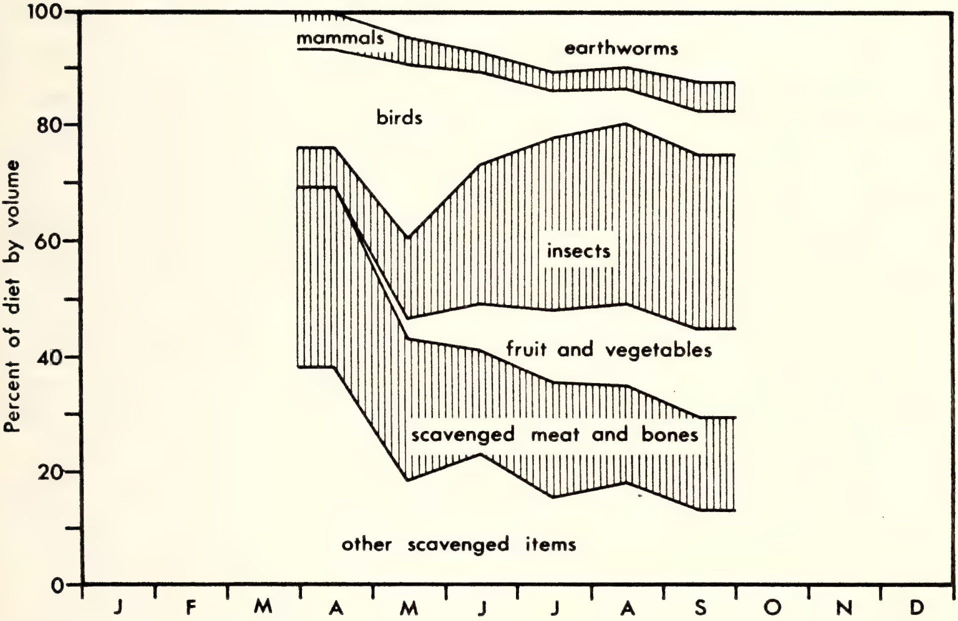
Volunteers along with conservation workers funded under recent Government schemes or employed by the NCC have assisted the two successive wardens. Major activities have included the felling of wych elm between 1976 and 1980 following the ravages of Dutch Elm disease, and the re-opening of views of the Gorge from Stokeleigh Camp. Areas of hazel north of the parish wall and lime

ERRATUM

BRISTOL'S URBAN ECOLOGY

Proceedings of the Bristol Naturalists' Society, Vol. 48, 1991 (for 1988)

The published version of Figure 3 on p.12 of Harris & Woollard's paper about Bristol's foxes is incorrect. The diagram wrongly repeats the data for Bristol's badgers shown on p.26, due to an editorial error. The correct version of Figure 3 for Bristol's foxes is given below, with apologies to the authors.



between the northern quarries have been coppiced. Scrub has been cleared from above the railway tunnels which historically were more open. A pond has been constructed and planted beside Stokeleigh Camp and, at the top of Nightingale Valley, an old rectangular stone-walled pond has been restored. Its long sides are vertical but the short sides are cobbled and slope gradually. It is shown on 19th century maps and mentioned in guide books (Baker, 1898) and was no doubt once used by the commoner's grazing stock.

THE WOODS OF ABBOTS LEIGH

The account of the southern holding has indicated that the Abbots Leigh portion of Leigh Woods was a wood in 1331 and 1568 and that coppicing and the felling of timber were practised in the late 14th century over an area of several hundred acres. The indicator species analysis and the abundance of lime and, less frequently, other types of coppice often with stools several hundred years old, convincingly demonstrate the continuity of woodland on the site. Indeed, a map of 1800 prepared in connection with the sale of the manor of Abbots Leigh, shows Leigh Wood as 129 hectares of which 119 are today wooded or afforested. The loss derives from quarrying (6.5 hectares), the railway of the early 1860s (1.6 hectares) and a mid 20th century angular encroachment near the village of Abbots Leigh (1.6 hectares). Gains exceed losses and Leigh Woods includes 156 hectares north of the parish wall.

Much research remains to be done before the historical ecology of this ancient wood can be satisfactorily understood. In particular, for any description of historical management we must at present rely on comments made in passing by local botanists to whom woodland practices were altogether unremarkable.

Writing in 1843, Dr Henry O. Stephens reported at some length the find of a garden escape, **Epimedium alpinum**, in about 1829. The site was "in the northern division of the wood" and Stephens added "Leigh wood is there coppice, which is cut in portions in rotation". The names and locations of the probable dozen or so sale compartments have yet to be discovered.

James W. White (1912, p.204) referred to the abundance of lime in Leigh Woods, citing specifically "the coppiced portions". Similarly he reported aspen coppice in "the preserved portion" (**ibid**, p.542). Both accounts describe with familiarity the large leaves of new coppice shoots: White's herbarium at Bristol University includes aspen specimens from the interior of Leigh Woods annotated "from bushes 8 to 10 feet high" (1892) and "stump shoots (not suckers) springing from cut underwood" (1893). Furthermore, White noted that one member of the ground flora, hairy St. John's wort, became "plentiful in the northern portions after cutting of the underwood". This phenomen is general and is now well-known to follow the temporary increase in light at ground level resulting from coppicing.

Three named areas are shown within the Leigh Woods of Abbots Leigh on present-day maps: The Paddock, Oak Wood and Paradise Bottom. From maps and recent field work something of their history can be extracted and shown to differ from that of the greater part of the woods.

The so-called Paddock derives from an early 19th century plantation of 8.5 hectares clearly shown to include conifers on the Tithe map of 1839. The plantation lay in wedge between the wood of 1800 to the north and the parish boundary to the south: in 1800 the woodlands of the two parishes were continuous only on the slopes of the Gorge. The Paddock is walled on its long sides and at the western end a shallow bank topped by yew trees of moderate age remains. Oral tradition recalls the felling of the plantation during the First World War (D'Oyly, 1975).

The paddock wall coincides not only with the southern boundary of Leigh Wood in 1800, but also with the earlier medieval boundary. This takes the classic form of a woodbank (see Rackham, 1986, p.99): the external ditch and internal bank here mark the previously unrecognised edge of the ancient wood. The wall, recently renovated at the edge of the NNR, there lies about four metres outside the ditch. Further east the paddock wall (where it remains) lies on top of the bank. Near the Gorge where the parish wall joins the paddock wall (rather than the reverse, significantly) the boundary becomes indistinct.

The woodbank continues westerly into the Forestry Commission holding, although in places local quarrying activities have destroyed the bank or further excavated or infilled the ditch. The boundary runs by a glade graced by a hornbeam pollard (illustrated by A. Sutherland on the title page of Micklewright **et al.**, 1986) and makes sense of the five tracks that meet there: two formed a path outside the wood and one approached the wood from the south and branched in two directions into the wood, thereby defining three compartments.

The medieval boundary extends north-westerly for 400 metres and beyond the "Carriage Drive" of about 1820 (now "Coronation Avenue" from the commemorative plantings). Near the edge of the present-day woods the ditchbank turns northwards and disappears at the (lower) Forestry Commission car park; a substantial wall surrounds this part of the bank which itself here reaches 1.5 m. The adjacent land was Leigh Warren, (part of the Leigh Down of 1568) some 263 hectares in 1800 and occupied then by Isaac Smith and his rabbits.

The recognition of the ancient wood boundary permits informative comparisons between the ancient and the more recent woodland and this comparison is facilitated by the availability of the maps of 1800 and 1839, both drawn to the same scale. Sycamore, a fashionable tree at the time (Rackham, 1986) was evidently planted beside the driveway and coppiced trees attest to the incorporation of this area into the managed wood of the 19th century. The paddock, as above stated, was apparently a conifer plantation. Between these areas, the Tithe map shows 8.5 hectares of "new plantation". This is the centre of the limited distribution of hornbeam in Leigh Woods but the tree also occurs beyond the "hornbeam glade" a short way into the ancient wood where the oldest trees are the dead stumps of sessile oak coppice. Hornbeam has generally been regarded as a native in Leigh Woods but its status requires re-examination: the largest coppice stool lies outside the ancient wood.

The second named area within the Leigh Woods is Oak Wood, a late 19th century name given to the northern-most part of the wood excluding Paradise Bottom. It has had a catastrophic history and indeed is not shown as a wood at all on the first edition one inch Ordnance Survey map, surveyed in about 1815 (see reproduction in Rackham, 1986). Some distinct features mark its southern edge.

The geological boundary between the alkaline and permeable Carboniferous Limestone rocks and the acidic and less permeable Old Red Sandstone deposits is marked by a spring and a marsh. The valley is the shortest and easiest route from Abbots Leigh to the river and must therefore have been in long usage. The path is almost the only internal woodland feature on the 1800 map. At the head of the valley is a row of huge and grotesque dead elm pollards whose size suggests they were over 250 years old, and therefore amongst the oldest wych elms in the country. A wall can be followed through the marsh (thus sharing a valuable facility), past a ruined building and to the bottom of the valley where it turns northwards. Lime is rare in Oak Wood but is quite abundant right up to the wall.

The wall is contemporaneous with the Carriage Drive to the lodge (formerly Blueacre Lodge, but recently re-named Oakwood Lodge) and Leigh Court. Although now diverted over the railway tunnel to the Towpath, the Tithe map of 1839 shows it to have originally delimited the park created with Leigh Court as its centre.

This park stretched beyond Paradise Bottom but was short-lived and was later divided: Oak Wood was re-united with Leigh Woods and the part of the park outside the wood and between Abbots Leigh and Leigh Court is shown as a deer park on the O.S. map of 1882.

Aerial photographs taken in 1947 indicate that felling of considerable areas of Leigh Woods had taken place with the need for timber in the Second World War (1939-45). The Home Timber Production Department of the Forestry Commission was based in a Bristol hotel for part of the war and the nearest woods of any size must have been an impossible temptation; in 1949 and in 1960 the Forestry Commission signed long-term leases with the Sir John Wills Estates and commenced their management as a commercial plantation woodland.

Much of the Oak Wood was grubbed-up for afforestation in the 1950s, being planted with beech, balsam poplar, red oak and various conifers. Some details are published in the Avon Gorge Forest Walk leaflet (Forestry Commission 1976) and aerial photographs of 1959 reveal the young plantations on the rough ground. This explains the sudden absence of lime, for few old trees remain, even as dead stumps.

As to the earlier history of this part of Leigh Wood, only suggestions can be made at present. Even the significance of the name "Oak Wood" is doubtful. It is not used in the Flora of Bristol (White, 1912) although it is shown on the 1921 edition of the 1882 O.S. map. The name may be derived by transfer of the old name for Paradise Bottom (see below). Even though oak coppice (**Quercus petraea**) indeed characterises that part of Cook's Folly Wood on sandstone on the immediately opposite bank of the Avon, such old trees as remain in the Oak Wood are more often not that species, but sweet chestnut (**Castanea sativa**). This is a Roman introduction into Britain, and although not a native tree, it is well known as a component of old woods, particularly on acid soils such as in the Forest of Dean (Rackham, 1986, p.56). Sweet chestnut also occurs south of the park wall, and there are large coppice stools: the introduction at least pre-dates the park.

Within Oak Wood, the characteristic form of the old trees is high coppice (or low pollards), the stubs being 1-2 metres high. Stubs (of lime and oak) also occur south of the Oak Wood although their distribution has yet to be mapped. This management (which matches that of the valley elms) suggests grazing by small animals was being practised at or after the chestnut plantings. The extent and duration of grazing are as yet unknown: the Abbey sheep (see Sabin, 1960) and the rabbits of Leigh Warren occupied the adjacent land before the park deer.

The third of the named areas in the Leigh Woods is Paradise Bottom and this includes the wooded slopes above the marsh. It was only later that the Forestry Commission gained control of this area and so it escaped the clearances suffered by Oak Wood in the 1950s. The Forestry Commission also regarded the slopes as unplantable (Micklewright, 1988) and so they retain considerable interest. The previous name (albeit confined to the marsh or meadow as it then was) was Oakham Mead. At the same time, the Gully below the Downs was called Oakham Slade. Micklewright (1985) convincingly argues for its derivation there from an Anglo-Saxon "Yew Coombe". As suggested above, the meadow name may have been transferred to the woods to the south.

The 1800-1801 survey records that the six acres of pasture in Oakham Mead had an annual value four times that of the woods, whose value was only six shillings per acre. In the same decade Bedford Purlieus, an ancient wood of similar size, was worth £1 per acre (Rixon, 1975). The Tithe map and apportionment again show the area as pasture. The presence of the uncommon purple willow (**Salix purpurea**), first noted in 1920, raises the possibility that the site had been planted as an osier bed in the intervening period.

In 1966 the Forestry Commission largely accepted conservation proposals made on behalf of the Somerset Trust for Nature Conservation by Colin Trapnell, who had recently returned to Bristol after 30 years as an ecologist in East Africa. Ten "conservation sites" were delimited, all near the car park and a general request to maintain all yew, oak and lime was made. Periodic reviews were requested by the Forestry Commission but the initiative did not survive the reorganisation of the county boundaries in 1974 and so the Avon Wildlife Trust did not inherit an advisory interest in the forest management. Nonetheless, sympathetic commercial management continued so that, for example, lime tree rich areas to the south and east of the car park in the Carriage Drive were retained "for educational purposes" (Forestry Commission, 1976) and fellings in 1979 left old trees standing.

More recently, under the aegis of the University of Bristol Avon Gorge Project, commissioned surveys of the forestry holding have been undertaken by Micklewright (1986, 1988) and his co-workers (1986). The prefaces of the last two references record the history of the Conservation Management Committee which has met twice-yearly since 1986. An important result is that the Forestry Commission holding has been accepted as one where special consideration should be given to nature conservation in addition to the commercial production of timber. The gradual replacement of non-indigenous conifers by native broad-leaved trees and a programme of lime coppicing are intended (Micklewright, 1988).

AMENITY USE

Although there is now unrestricted access on foot to most of Leigh Woods, public pressure is remarkably slight, largely owing to the greater attractions of nearby Ashton Park. Simple recreational use predominates, either enjoying the freedom to explore a wild expanse or to undertake what Rackham has termed 'dog-emptying'. The former towpath is now a cycle track and a little rock-climbing occurs in the quarries, one of which is also used for shooting. Petty acts of vandalism are sometimes seen and, until its entrance became overgrown recently, another quarry was sometimes used for motor-cycle scrambling and as a barbeque site. Tramps have from time to time inhabited the woods.

Interpretive facilities are few. A four-page leaflet can be bought in the Nature Reserve and display boards at the boundaries of the NNR summarise the leaflet. Only temporary nature trails have been established there owing to the sensitive nature of the site and fears of damage. Neither of the wardens has habitually led field meetings and this has been left to societies such as our own, or to informal groups. The forestry holding has a display map by the car park showing several recommended walks and coloured arrows mark the routes on the ground, but the descriptive leaflet no longer seems to be available on site.

CONCLUSION

Leigh Woods are a complex product of the changes wrought by man on the natural wildwood which existed there some six thousand years ago. A place of constant surprise to the enquiring naturalist, paradoxically the survival of so much of interest owes as much to the proximity of Bristol as to the difficulties of access imposed by the topography. Once the woods fell out of traditional use, so they were acquired, piece by piece, by a family whose wealth derived from the tobacco plant shipped from overseas to the Port of Bristol, through the Avon Gorge and under these very Leigh Woods. Gifts and grants of leases by the Wills family have ensured the survival of Leigh Woods during a century when so much ancient landscape has been lost.

Enough has been written here to justify Oliver Rackham's remark quoted in the opening paragraph that the Avon Gorge is a place of exceptional interest for the archaeology of vegetation and there is now little doubt that Leigh Woods deserve an extensive publication on their history and ecology, such as are presently available for three other lowland English woods, Monks Wood (Steel & Welch, 1973), Bedford Purlieus (Peterken & Welch, 1975) and Hayley Wood (Rackham, 1975). Much research and documentation remains to be undertaken both in the field and in the archives and the assistance of specialists in different disciplines would be required. What is abundantly clear is that Leigh Woods can only be properly understood by reference to their historical boundaries rather than to those of current management and this fact alone should have profound influence on future research, education and conservation in Leigh Woods.

ACKNOWLEDGEMENTS

I am grateful to Dr L.C. Frost of the Department of Botany at Bristol University who supervised my research on the Avon Gorge between 1977 and 1981 (funded by the Natural Environment Research Council). He has continued to encourage my interest, providing his essay in Micklewright (1986) as an early draft of this paper. P.J.M. Nethercott first introduced me to the woods in 1977 and pointed out both the parish wall and the contrasting nature of the woodland on either side. I am indebted to Dr O. Rackham both for the influence of his writings on historical ecology and for the experience of joining him in the field in Cambridgeshire and in the Avon Gorge.

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Proceedings of the Bristol Naturalists' Society (1987), **47**: 21-26

HISTORICAL LAND USE OF THE BRISTOL DOWNS AS COMMON OF PASTURE

by S.D. MICKLEWRIGHT and L.C. FROST

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In Atlantic times (7,500-5,000 years before present) it is likely that Clifton and Durdham Downs were covered by the "wildwood", consisting of small-leaved lime, sessile oak, ash, wych elm and field maple, with hazel and other shrubs. However, a series of of archaeological survivals, namely the megalithic chambered tomb of Neolithic Age at Druids Hill; the "Seven Sisters" (interpreted as a Bronze Age round barrow on a high point on Durdham Down); the Iron Age field system ("Celtic Fields") by the Ranger's Pound; the promontory fort of Clifton Down Camp on Observatory Hill of the same age, and the Roman Road (**Via Julia**) across Durdham Down, all point to an early commencement to clearance of the wildwood by man allowing the use of the exposed plateau for grazing purposes and of the lower-lying, more sheltered, areas for ploughland.

Early confirmatory documentary evidence comes from the Anglo-Saxon Charter of 883 AD conferring grazing rights on an area including a large part of Durdham Down. The perambulation of the boundaries encompassed the bottom of the Gully, then called "Eowcumbe" (Yew Tree Combe, thus making Yew the oldest recorded plant in the Avon Gorge), thence across the Downs to near the Water Tower. This ancient boundary is still marked today by seven sets of weathered boundary stones; called "Merestones" in 1627 in the survey of *The Metes and Bounds of the Parish of Clifton*, and "Meere stones" in 1746 in *The Survey of the Manor of Clifton*. These words are derived from the Anglo-Saxon "mǣrestān", a boundary stone. This line still today forms the boundary between a number of administrations, being the meeting point between the ancient Parishes of Clifton (a Saxon name) and Westbury, between Clifton and Durdham Downs, the extended boundary from 1859 of the City and County of Bristol, and also the Parliamentary boundary.

The first use of the term "common of pasture" can be traced back to the end of the 12th century, when Roger de Clifton granted by Charter to the Abbey of St. Augustine (founded in Bristol in 1148), "common of pasture in his Manor of Clifton". After the Dissolution, all of the Manorial lands passed by 1686 into the ownership of the Society of Merchant Venturers. Down the centuries the Society protected the common rights and fought off encroachments, though not always with success.

A wealth of detail regarding the control of the Commoners and their grazing rights on Durdham Down comes from the medieval *Court Book of the Manor of Henbury*. For example, here in 1599 swingeing fines of up to 39s 11½d were imposed for offences such as "overpressinge the Common with sheepe and other Catle", "incrochinge and tynninge in (a Middle English west country dialect word for fencing-off) of the Common", and "for puttinge Sheepe and other Catle into the Comons wher of right she hath none" poor "Marie Haynes, widow". An official Shepherd supervised the animals which had to be brought in each night by their owners.

In the Churchwarden's Book of St. Andrews, Clifton, the church path which crossed the Downs to St. Lambert's Chapel (by the present water tower), was described in about 1717 as passing over "the tough and thick turf of an ancient pasture". The Vestry Books recorded that in 1805 the "Constable" was charged with impounding all stray asses and pigs running about in the Parish into the Pound on Clifton Green. In 1806, Clifton Down was described as assuming "a barren and neglected aspect, whose surface produces only a short mournful grass, furnishing support to a few sheep". Perhaps it was being overgrazed in a time of drought.

That overgrazing was a possibility results from the investigations into the Commoners of the two Downs. Common rights were bestowed upon properties and their successive owners, not upon persons. From The Survey of the Manor of Clifton in 1746, a list of Commoners and their rights was reconstructed. In all there were 23 properties with rights to graze a total of 880 sheep and 14 "neats" (Old English for one head of cattle), plus unlimited numbers by the Lords of the Manor.

Careful records have been kept by the Clerks to the Commoners of Durdham Down and a total of 1,885 sheep can lawfully be grazed on that Down; a total divided into quotas amongst the Commoners, and revised from time to time as the older properties become sub-divided into a number of owners. Allowing for serious and unlawful encroachments of Durdham Down (in spite of protests by the Commoners), particularly in the 18th and 19th centuries, then a minimum figure of five animals to the acre is obtained; a high stocking level. Because of these encroachments, Bristol City Council purchased Durdham Down from the Lords of Henbury Manor, and turned out their own sheep to graze, in preparation for the Downs Parliamentary Act of 1861.

PLATE 1 One of the historic "merestones" beside Ladies Mile. Modern recreational use of the Downs can be seen in the background of the picture. (From S.D. Micklewright, Avon Gorge Project Report No. 10, 1988).

However, most of the Commoners of Clifton Down had lost their rights through "non-user" by around 1847, their interest having changed to property speculation and building. This situation is confirmed by the Book of Past Accounts held by the Society of Merchant Venturers and also by the recorded remarks regarding Common Rights by a solicitor in 1859 that "three, or perhaps four, at the utmost, are in legal existence in Clifton", seemingly confirmed by the Town Clerk of Bristol who stated that only three persons claimed Common Rights on Clifton Down at the time of the Downs Act.

Unlike their feckless Clifton counterparts, the Commoners of Durdham Down continued to graze their sheep and even allowed them to wander onto Clifton Down. Hence the recorded complaint in 1909 by the Manager of the Clifton Down Hotel (by the Suspension Bridge) that the "continual bleating" of the sheep was annoying his guests. The ancient rights of the Commoners can be traced back to the Norman Law as "commons pour cause de vicinage", that is there were "Wrangle rights" such that the Durdham Commoners were legally entitled to graze their sheep on Clifton Down and **vice versa.** Such intercommoning rights are now known to date back some 1,500 years, to a time before estate boundaries were fully defined. In this connection, the northern part of Clifton Down was called in 1746, "Part of Durdham Down in Clifton".

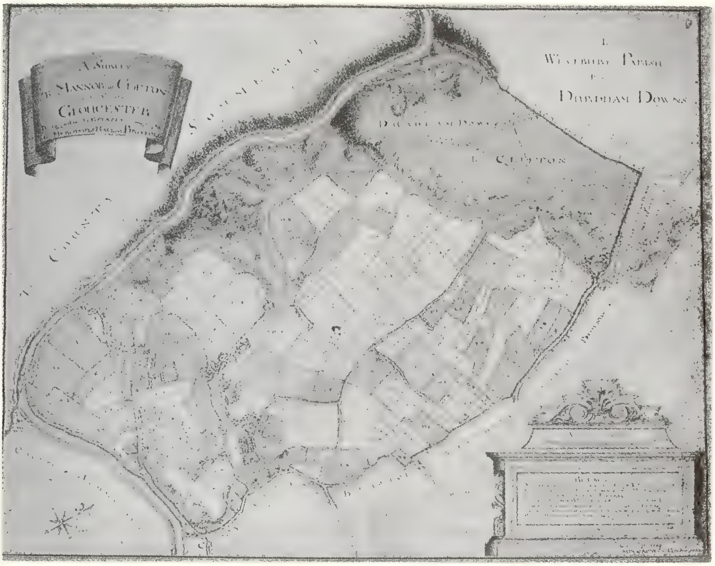

PLATE 2 Map to 'A Survey of the Mannor of Clifton in the County of Gloucester', by J. de Wilstar, 1746, copied by courtesy of The Society of Merchant Venturers. The large number of open meadows and fields, and a few dwellings of Clifton are evident as are numerous small quarries on "Durdham Downs in Clifton". (From S.D. Micklewright, Avon Gorge Project Report No. 4, 1985).

However, with time, grazing also declined on Durdham Down. In 1872 "only three or four hundred sheep" were reported on the Downs. In 1909 the "large number" of sheep was greatly reduced owing to drought. No sheep were grazed during the first world war, and a shepherd was not re-appointed until 1920. In 1924, there was a serious outbreak of sheep scab such that the Ministry of Agriculture issued a banning order on grazing and from then on regular grazing on the Downs ceased.

The cessation of sheep grazing was an ecological disaster. Already, with the reduction in grazing on Clifton Down, scrub and trees were rapidly colonising the little-grazed areas. This is revealed in the many sketches, etchings and paintings, especially by the Bristol School of Artists, from as early as 1753, but particularly during the 19th century. Towards the end of that century and into the present one, photographs and picture postcards continue the visual story. Soon the treeless, close-cropped turf shown in the 1830's from Observatory Hill to Fairyland was overwhelmed by thickets of scrub and, along the edges of the Gorge, trees took root. By about 1900, scrub was invading all around the outcrop of Dolomitic Conglomerate above Bridge Valley Road. In about 1916, scrub was invading the Conglomerate itself and Fairyland was already overgrown.

Although the rights of the Commoners were preserved in the Downs Act of 1861, the Downs Committee (a joint one of Bristol City Councillors and Merchant Venturers) was charged with managing the Downs, and appointed a "Planting and Thinning Sub-Committee". The latter was seized with the irrational notion to "beautify" the Downs, which it did by enclosed plantings from 1871 onwards of large numbers of trees, many of them aliens especially Austrian and Tyrol pines, and to cast quantities of seed of gorse, lucerne and "gillyflowers" (wallflowers) around the Gully and the edges of the Downs overlooking the Gorge. Their much-needed attempts to clear the ever-increasing thickets of scrub were thwarted by an outcry by J.W. White and the Bristol Naturalists' Society, both ignorant of the principles of ecology, then a science in its infancy.

Just as had happened earlier on Clifton Down, the planted alien pines, well-adapted to the soils and micro-climate of the Gorge, spread with amazing rapidity in the Gully and around Durdham Down, following the cessation of grazing in 1924. In 1863, a watercolour showed the south-facing slopes of the Gully closely-cropped and heavily poached. In 1905, a photograph showed the planted pines, but the rest well-grazed and with sheep terraces. A photograph in 1935 showed that the pines had regenerated enormously but there was still open turf. However, by 1964, the whole was engulfed in a degenerate form of secondary woodland, riddled with aliens. The other source of these aliens were "garden escapes" from the mansions bordering the Downs, resplendent with the spoils of Victorian plant hunters. Thus pernicious evergreen holm oak, laurestinus, sycamores, cotoneasters and buddleja also invaded the Gorge and Downs.

One year after the cessation of sheep grazing, horse-drawn mowers had to be used (at the ratepayers' expense) on the Downs, later to be replaced by motorized gang mowers. To aid the mowers and the laying out of football and cricket pitches, pits and depressions (pleasing surface features) were infilled and the gorse thickets and bracken breaks (a feature of sheep-grazed downland) were destroyed, in spite of their importance to wildlife, especially birds. Whilst the mowers carried out one of the vital functions of sheep (and rabbits), namely cutting off the seedlings of scrub and trees, these machines could not be used on rough or steeply-sloping ground, which the agile sheep had reached in the past. Accordingly, the overgrowth of such areas was promoted and rapidly the Downs began to lose their historical character as a unique stretch of English downland, degenerating instead into a bland municipal park.

With the spread of secondary woodland and thickets rife with aliens and the over-mowing of the Downs turf, many of the three dozen or more rare and uncommon native plants, for which the Gorge and its environs are internationally famous and whose historical record is unparalleled in Britain, were driven into an ever decreasing number of rocky refuges, whose skeletal soils could not support scrub or trees. In the days of sheep grazing, Bristol rock-cress (a protected plant) and rock hutchinsia would have found the abundant open screes a welcoming habitat. Nationally-rare and threatened honewort would have flourished in the ancient grazed turf (as it still does at sheep-grazed Sand Point, Uphill and Crook Peak). So too would nit-grass, recorded historically at nine stations in the Gorge, but just surviving today in only two sites. The rare autumn squill, historically scattered about the grazed cliffs, is today reduced to less than half a dozen plants and facing extinction.

Following the cessation of sheep grazing in 1924, the Commoners of Durdham Down have grazed a few sheep from time to time on the Down to retain their ancient rights. In 1977, the University of Bristol, the only Commoners still to own sheep, took on this task with a symbolic grazing ceremony by two sheep, "Emma" and "Flower". The ceremony was repeated in 1987 with three Clun Forest sheep, a ram and two ewes. Let us hope that this gesture will encourage others to take a more constructive, instead of destructive, attitude to the Gorge and Downs.

PLATE 3 Sheep grazing on Durdham Downs c. 1900. The Seven Sisters, planted with Austrian pines, can be seen on the left. (From S.D. Micklewright, Avon Gorge Project Report No. 10, 1988).

Already the Nature Conservancy Council's Warden and the Downs Ranger are effecting important scrub-clearing operations. There are signs, too, that the Downs Committee is considering implementing new management régimes on the Downs, in order to restore some of the traditional features embodied in this historic and unrivalled tract of English downland, which has been grazed by sheep for probably 1,500 years or more.

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City of Bristol Museum and Art Gallery, the staff of the Bristol Record Office, Mr G. Millward, the Downs Ranger and Mr P. Mountford, the NCC Avon Gorge Warden. We are most grateful to Miss E. Ralph, Archivist at the Society of Merchant Venturers, the Secretary of the Society and Mr G. Niblett, Clerk to the Commoners of Durdham Down, for directing our attention to many important documents in their care. Contributors to the University's Avon Gorge Appeal are thanked for making the work reported here possible.

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NATURE'S PLACE IN THE AVON GORGE

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AVON GORGE PAST

In 1825, Samuel Jackson sat at the northern end of Observatory Hill and painted the view towards Sea Wall. His superb painting, now in the City Museum, shows the Downs as a bare landscape of native wild grasses and a few shrubs, grazed by sheep. I sat in this same place in August 1987 and the view before me was blocked out by a large mass of scrub and a huge sycamore, an alien species. In 1912, J.W. White commented on the abundance of small-leaved lime coppice in Leigh Woods. During a survey of the Forestry Commission woodland in 1985, we considered it to be heavily over-planted with beech and non-native conifers. The surviving small-leaved lime had not been coppiced for decades and was tall, derelict and degenerating.

Were Samuel Jackson or J.W. White able to see the Gorge of today, they would be stunned at the changes which have occurred. Many of the places where Jackson admired the view and painted the superb landscape have been obliterated by secondary woodland, invaded by alien species, and a considerable number of J.W. White's localities for the less common wild flowers have been overgrown. However, both would be gratified that the hideous quarries on both sides of the Gorge are now closed and their scars slowly healing.

AVON GORGE PRESENT

The Avon Gorge remains a very beautiful place and there is still much that the historian, geologist or botanist can delight in studying. For example, despite the absence of sensitive management, there are still some thirty-six rare or uncommon plants growing in the Gorge and there remain places where fine views can be enjoyed.

However, the lesson of the last one hundred and fifty years is that the remaining vistas of natural beauty and the surviving pockets of rare plants will surely also be lost if active conservation measures are not implemented.

AVON GORGE CONSERVATION

Since 1983, I have been engaged by the University of Bristol Avon Gorge Project to investigate ways in which the wildlife and character of the Gorge and its environs can be conserved.

Arguably the most important botanical features of the Avon Gorge are its assemblage of rare plants, the associated limestone grasslands and the ancient woodlands. The gradual colonisation of the Gorge by trees and shrubs, many of them alien species, has resulted in the dramatic decline of the limestone flora and, at present, only a few pockets survive. To protect these sites, invading scrub is being removed to allow the rare plants to flourish. Furthermore, the grassland is also cut in the autumn at some of the accessible sites in order to discourage the regrowth of scrub and the establishment of coarse grasses, which would obliterate the more delicate rarities. This hard work is beginning to yield results as scrub is removed from the ledges of St. Vincents Rocks, the Gully and various sites below Leigh Woods. For example, following scrub clearance at the site of the endemic hybrid orchid, **Ophrys** x **pietzschii**, it flowered for the first time in three years.

Once all the surviving sites for rarities have been cleared, they will be encouraged to spread by removing scrub from neighbouring areas which formerly supported limestone grassland. This work is being expertly undertaken by Mr P. Mountford (Warden of the Avon Gorge National Nature Reserve) and his work team and will ensure that there will remain sites for such plants as the western spiked speedwell, Bristol rock-cress and the round-headed leek (all three now protected plants under the recently revised schedule to the Wildlife and Countryside Act of 1981) and also for such nationally rare and threatened plants as the honewort, little robin and nit-grass.

A few of the Gorge's rarities have been lost, including the sea clover which was finally destroyed by the construction of the Portway. Others have declined to such an extent that they may disappear from the Gorge altogether. The first attempt at conservation in the Gorge was undertaken by Brunel during the construction of the Suspension Bridge, when it was realised that a site of the rare autumn squill would be lost. The plants were painstakingly dug up and moved to a safe locality. At the present time, the autumn squill is so endangered in the Gorge that Mr M.D. Ames of the University's experimental greenhouse is raising plants from seed for reintroduction to the Gorge in the near future. The conservation of this species is particularly important because it has been found to be cytologically distinct from other colonies of autumn squill in south-west England.

The Gallery Roof over the Portway has provided a considerable area of new land surface and a perfect opportunity to create a new scree habitat in the Gorge. Screes were once a feature of the area, but have been gradually lost due to quarrying and scrub encroachment following the decline of sheep grazing on the Downs. The careful design of the roof infill (Byfield, Ames & Frost, 1984) has allowed the successful introduction of western spiked speedwell, compact brome and honewort onto the roof. Furthermore, the speedwell, little robin and rock hutchinsia have all colonised the roof spontaneously.

LEIGH WOODS

The Avon Gorge National Nature Reserve, which covers only the southern part of Leigh Woods, is managed by the Nature Conservancy Council. Much of the conservation work so far carried out has involved the removal of invasive ash and sycamore which have further colonised the woodland since the devastation of wych elm by Dutch elm disease. The area around Stokeleigh Camp has been cleared to encourage the grassland to re-establish and also to expose the Iron Age encampment. The historical use of this area was as wood-pasture and it is unfortunate that the recreational use of the site makes it unsuitable for the re-introduction of sheep. Furthermore, an important area of small-leaved lime at Lily Point has now been coppiced which should rejuvenate the lily-of-the-valley and angular solomons-seal which still survive there.

Much of the historic Abbots Leigh Woods is managed by the Forestry Commission as a commercial forest with free public access. A survey of the woodland in 1985 (Micklewright, Lawrence & Higgins, 1985) showed that there were still areas of value to wildlife, despite the rather unsympathetic management practices. Furthermore, many of the woodland rides supported an excellent grassland flora and also provided the last refuges for some of the more sensitive woodland plants, especially ancient woodland indicator species, such as the rare and declining wood vetch, which proved to be well scattered along the ride edges.

As a result of this survey, a Conservation Management Advisory Committee was established to help the Commission combine commercial forestry with nature conservation. An examination of the rides was undertaken (Micklewright, 1987) which has resulted in the Commission widening many of the rides to provide an improved habitat for grassland flowers, butterflies and birds. A dense shrubby edge will be allowed to develop along these new, wide rides which will provide nesting sites for birds and refuges for those woodland flowers sensitive to dense shade. More recently, an evaluation of the status of small-leaved lime and its associated flora and fauna has been undertaken (Micklewright, 1988). It has been recommended that the Commission manages certain sections of the lime woodland in a traditional way by a coppice rotation. This will rejuvenate the derelict lime coppice and also provide periods of time when light falls on the forest floor. Consequently, the hard-pressed woodland ground flora should re-establish.

PLATE 1 A view across the Downs from Upper Belgrave Road to the Water Tower. The scattered thickets give a pleasing impression of depth and expanse.
(From S.D. Micklewright, Avon Gorge Project Report No. 13, 1988).

THE DOWNS

The Downs were once a superb wildlife haven providing homes for typical downland plants and birds, but they are increasingly managed in the style of a municipal park with little attention paid to wildlife requirements. Most of the area is mown frequently during the summer producing a rather dull grassland full of buttercups, dandelions and daisies. It is no longer possible to find such birds as the hawfinch, nightingale or skylark nesting on the Downs (Morley, c.

1935/36), and there are now only a few places where one can still find formerly common plants such as yellow rattle or meadowsweet.

However, there is a great opportunity to combine the recreational use of the Downs with wildlife conservation. A survey of the Downs was undertaken during 1987 (Micklewright, 1988) which found that there were still areas of wild grassland to be found. Of particular importance is the area opposite the Bristol Zoo which still supports populations of the rare spring cinquefoil and autumn ladies-tresses as well as many other downland plants. The old lead quarries, unjustifiably known as "The Dumps", opposite Upper Belgrave Road, also support an excellent flora including beautiful patches of wild thyme, a plant which graced large areas of the Downs in former times but is now confined to a few patches where gang mowers cannot reach. Furthermore, the combination of wild grassland and native shrubs has produced a more favourable habitat for birds. Some of the wooded slopes, formerly grazed downland, are also important, providing cover for a variety of wildlife, not least the foxes which seem to be ever-present on the Downs at night.

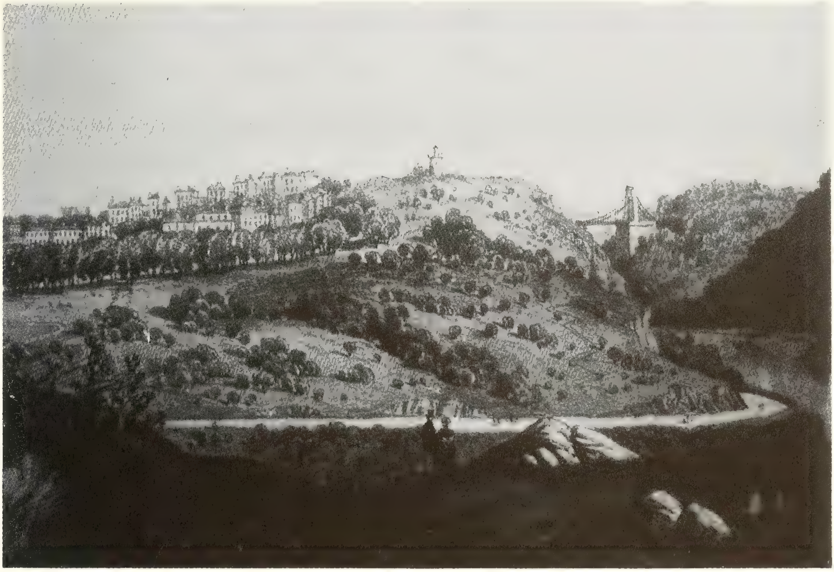
The Downs provide an ideal opportunity to create new habitats for wildlife. Sensitive management of the wooded slopes, including removal of Austrian pine, holm oak and other alien trees would result in an increase in the dwindling birdlife and allow the establishment of an attractive and diverse woodland ground flora. The Downs are naturally devoid of a fresh water supply, but the creation of some strategically placed ponds, fenced-in for safety, could provide sources of water which are so important if wildlife is to thrive. Some grassy areas could be mown just once a year and the cuttings collected, resulting in the establishment of hay meadows rich in wild flowers and their associated butterflies. Other grassy areas could be mown less frequently to allow some of the existing plants the chance to flower for the first time in many years. All these changes could be fitted around the present activities which take place on the Downs. No football pitches or sites for fun fairs and flower shows would be lost, but harebells, scabious and even horseshoe vetch, which White so admired, could become a common feature of Bristol's unique Downs for a second time. Indeed, during 1988, the Downs Ranger left un-mown a small trial area on the grassy Downs with the surprising result that bee orchids and drifts of harebells, ox-eye daisies, dropwort and lesser knapweed made a most welcome and attractive re-appearance.

AVON GORGE FUTURE

It would be good to think that sometime in the future the successors of Samuel Jackson and J.W. White might be able to visit the Gorge and enjoy splendid views, wild flowers in abundance and woodlands echoing with bird song. At the present time we can only be optimistic about the future of the Avon Gorge; the rare plants are finally receiving the practical conservation they deserve, Leigh Woods is beginning to be managed for wildlife as well as timber production and the officials responsible for the Downs are expressing much interest in returning the area to its former glory. Some 300 private individuals contributed to the Bristol University Avon Gorge Appeal and, in a public attitude survey carried out in 1987 (Evans, 1988) of almost 500 visitors to the Downs, a majority showed interest and concern for the area. Clearly, there is a large body of local opinion which cares deeply for the Gorge and its surroundings and wish it to be conserved for posterity.

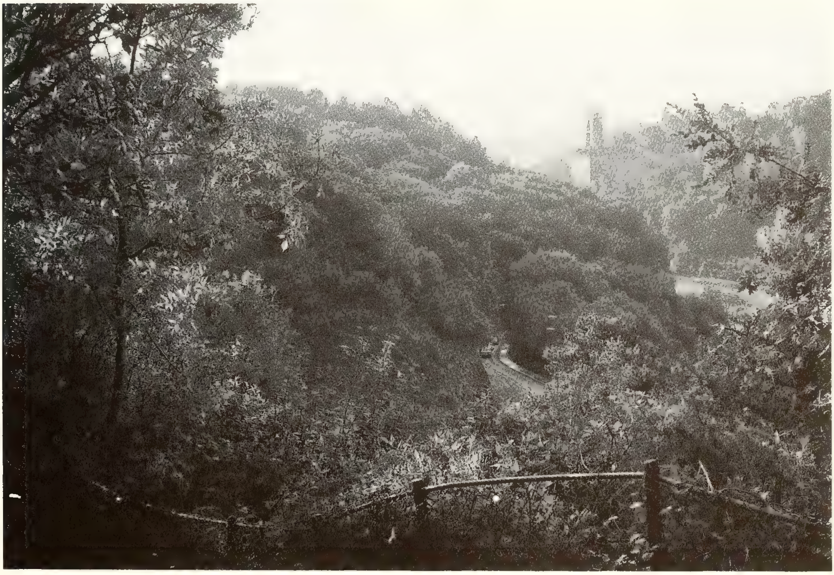
ACKNOWLEDGEMENTS

I wish to thank all my colleagues and friends who have assisted me in my



PLATES 2 and 3 (Above) "Observatory Hill", by an unknown artist, c. 1843, copied by courtesy of the City of Bristol Museum and Art Gallery and (below) from a similar viewpoint in 1987. (From S.D. Micklewright, Avon Gorge Project Report No. 10, 1988).

The reduction in intensity of sheep grazing from 1847 to its cessation in 1925 has resulted in the colonisation of most of the area by dense secondary woodland.



studies in the Avon Gorge since 1983, especially Dr L.C. Frost for his help, support and encouragement. Contributors to the University's Avon Gorge Appeal are thanked for financing my work and the Avon Wildlife Trust for their valued support.

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A REVIEW OF THE ALIEN AND INTRODUCED PLANTS OF THE AVON GORGE

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INTRODUCTION

The Avon Gorge has long been recognised as a botanical 'Mecca' and it has been visited by most of the leading botanists of the day over the last 400 years or so. Its flora has also been studied by a succession of local botanists, amateur and professional alike, and by students and staff of the Botany Department of the University of Bristol: as a result, its unique flora is perhaps the best-documented of all local floras.

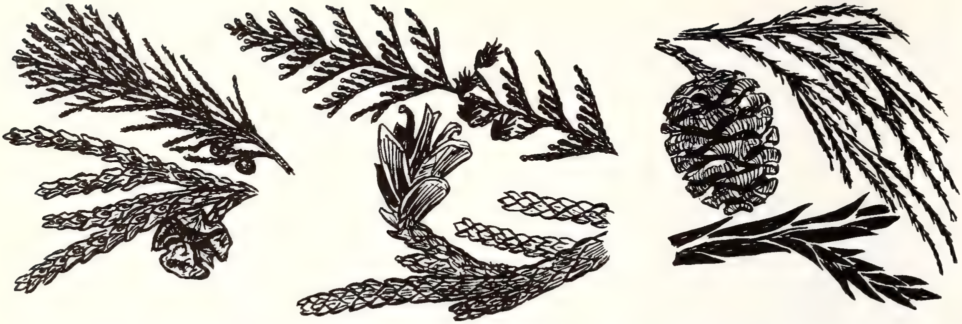
Sadly, much of the limestone grassland, formerly the home of many of the rare plants for which the Gorge is renowned, has become overgrown with scrub and secondary woodland dominated by alien plants. Neglect and inaction have aided this transformation but the cessation of sheep grazing in 1924 has been the largest contributary factor. Before that time the many plants introduced directly by man, or indirectly from his gardens, were largely kept in check by grazing. Various attempts at 'tidying up' have been made over the years but it was not until the mid-1980s that concerted efforts were made to control the encroaching scrub and to conserve the unique flora of the Gorge. Let us hope that it is not too late!

A great many casual species have occurred along the Portway during the last fifty or sixty years: most of them introduced by traffic from the Avonmouth docks. Many more were recorded on the Portway tip in the late 1940s and early 1950s. These are outside the scope of this paper, which concentrates on species which have had the greatest impact on the landscape and which have had such a disastrous effect on the native flora.

English names used are those most popular locally: scientific names, printed in bold type, are used without authorities. Opinions expressed on conservation issues are those of the author alone. The area covered encompasses the Avon Gorge from Hotwells to the Horseshoe Bend, Leigh Woods and Burwalls on the west of the river and Clifton Down, Durdham Down and Cook's Folly Wood on the east side (formerly in Gloucestershire) but now part of Avon county. The map on pages 8 and 9 of this book will be useful in interpreting place names.

TREES AND SHRUBS

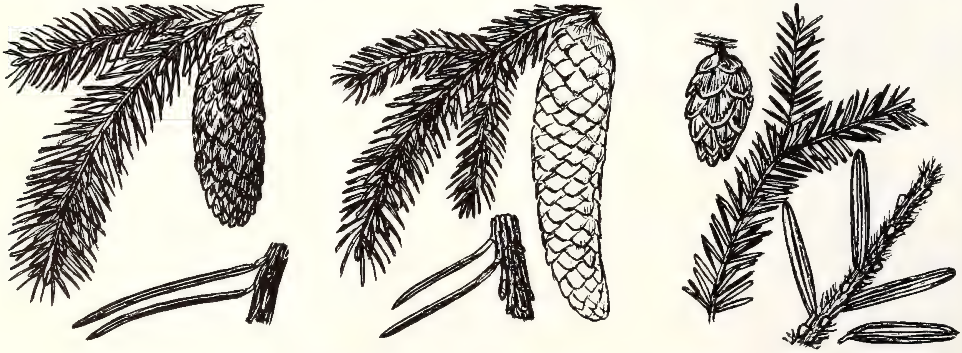
Conifers are well represented throughout the area, especially in Leigh Woods where European larch (**Larix decidua**), Austrian pine (**Pinus nigra** ssp. **nigra**), Norway spruce (**Picea abies**) perhaps better known as the 'Christmas tree', Sitka spruce (**P. sitchensis**) and western hemlock (**Tsuga heterophylla**) have been widely planted by the Forestry Commission since the 1950s. Underplantings of the western red cedar (**Thuja plicata**) have been largely removed during the last few years. The similar Lawson cypress (**Chamaecyparis lawsoniana**) is planted in the vicinity of the Forestry Commission car park. Coast redwood (**Sequoia sempervirens**) may be seen below Blue Acre Lodge and there is a small group of the Japanese larch (**Larix kaempferi**) in nearby Oak Wood. Corsican pine (**Pinus nigra** ssp. **laricio**), planted many years ago in small groups of two to three trees on the gorge edge in Leigh Woods, is still to be seen. Both lodgepole pine (**P. contorta**) and giant



Chamaecyparis lawsoniana **Thuja plicata** **Sequoiadendron giganteum**

redwood or Wellingtonia (**Sequoiadendron giganteum**) also grow in Leigh Woods.

On the Bristol side, Black Rock Gully and the edges of the Downs nearby were chosen for 'improvement' in the 1870s by the "Planting and Thinning Sub-Committee" of the Downs Committee, formed to manage the Downs and thus responsible for so many bizarre, ill-considered and thoughtless introductions. The first of these introductions, Austrian pine, so well-adapted to the micro-climate of the Gorge, was planted from 1871 and is still to be seen in quantity in the Black Rock Gully and about Sea Walls where it might appear indigenous to the casual observer. The thick carpets of dead needles collecting under its branches pose a considerable threat to the native flora. The 'Seven Sisters' (see Plate 3, page 25) which in fact number only six (no-one seems to know what became of the seventh or if indeed it ever existed), are Austrian pines and probably date from the same period. Scots pine (**P. sylvestris**) is planted on the north side of the Downs, in the Gully and in Leigh Woods: however, this is the commonly introduced form from the Iberian Peninsula, not our native Caledonian tree. At the top of Bridge Valley Road is a specimen Wellingtonia (from California) and, on the other side of the road opposite the Clifton Zoological Gardens, a monkey-puzzle or Chile pine (**Araucaria araucana**), one of two originally planted, survives.



Picea sitchensis **P. abies** **Tsuga heterophylla**

Evergreen sweet bay (**Laurus nobilis**), from the Mediterranean region, is still to be seen on St. Vincents Rocks near the Observatory on Clifton Down where it was originally planted. It seeds itself well in the equable climate of the Gorge.

Oregon grape (**Mahonia aquifolium**) from W.N. America occurs in woodland on the Conglomerate above Bridge Valley Road and elsewhere in the Gorge.

Small-leaved lime (**Tilia cordata**) is an important element of the local woodland but it is only in very recent years that large-leaved lime (**Tilia platyphyllos**) has been recognised as indigenous following its discovery in small quantity in Leigh Woods. The hybrid arising from the crossing of these two species, common lime (**T. x europaea**), has been extensively planted as an amenity tree on the Downs where many fine, large specimens may be seen. Recently, common lime together with both of its parents and the hybrid Caucasian lime (**T. x euchlora**) have been employed on the Downs to fill the gaps resulting from the devastation of the elms by Dutch elm disease. This latter hybrid, favoured for its insect-free foliage, is believed to result from crossing of another Caucasian lime (**T. dasystyla**) with **T. cordata.** A word of warning regarding the identification of limes; leaf size can vary enormously in both saplings and coppiced trees, sometimes by as much as a factor of four. This abnormal leaf enlargement, or hypertrophy, is noticed for several years before typical leaves are produced at maturity.

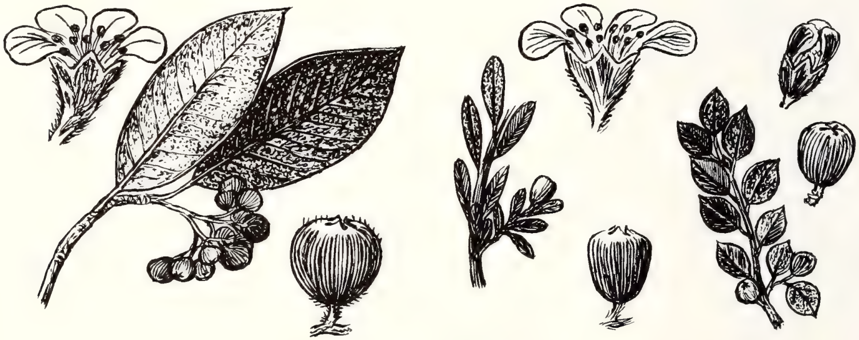
The maples (**Acer** species) also feature prominently, with 'forester's weed' sycamore (**A. pseudoplatanus**) especially abundant throughout. Probably introduced into Britain in the 17th century, it has been widely planted since about 1820 when it was a very fashionable tree. It derives a competitive edge in woodland by opening its leaves early in the season; it also seeds extremely freely. Such is its dominance in parts of Leigh Woods that control is now a matter of urgency. The fashionable variety 'Atropurpureum', with leaves a rich dark purple beneath, has been planted on the Downs. Norway Maple (**A. platanoides**) was first planted in the area by the recently-formed National Trust in Leigh Woods north of Stokeleigh Camp during the First World War. Also used as an amenity tree on the Portway, it is widely naturalised on both sides of the River Avon especially in Leigh Woods. Like the preceding species, it also seeds itself well and is just as invasive, posing a similar threat to the native woodland. Unlike sycamore, Norway maple flowers before the leaves; its erect panicles of bright yellow-green flowers contrast with the inconspicuous pendulous racemes of sycamore which appear at the same time as the leaves. Silver maple (**A. saccharinum**) has become popular in the Bristol area in recent years and is planted on the Downs: its value as an amenity tree, however, must be in question in view of the brittle nature of its branches which renders it so vulnerable to wind. The fruits are seldom seen in Britain and so it is unlikely to become naturalised here. Also planted on the Downs is the downy Japanese maple (**A. japonicum**); a few fine specimens of red snake-bark maple (**A. capillipes**), also originating from Japan, with three-lobed leaves and striped green and white bark, can be seen in Leigh Woods near Abbots Leigh.

Horse chestnut (**Aesculus hippocastanum**), from Albania and Greece, seems particularly suited to the British climate and thrives on the northern parts of Durdham Down where it is planted extensively near the White Tree and Parry's Lane. Popular for its abundant showy panicles of white flowers, its large compound leaves, its 'sticky buds' and its ever sought-after 'conkers' pillaged each year by children in late summer. Red horse chestnut (**A. carnea**), a fertile true-breeding hybrid between the former and the American red buck-eye (**A. pavia**), is planted near the Suspension Bridge. It is slow-growing, short-lived, prone to disease and its fruits lack the appeal of the those of the former (Mitchell, 1974).

Gorse (**Ulex europaeus**), although a native, has been widely planted in the Gorge especially in Black Rock Gully. It flowers during eight months of the year.

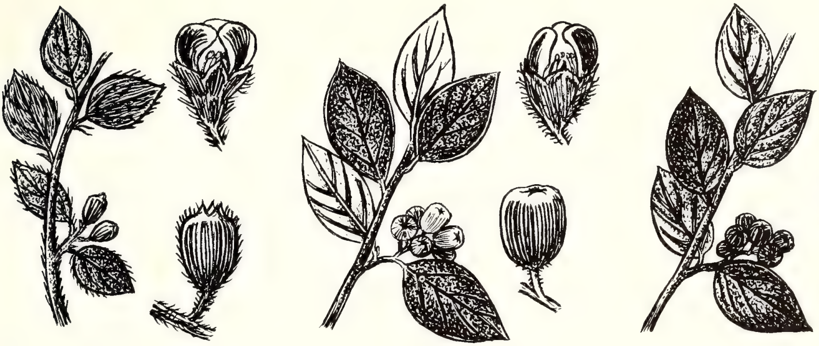
Laburnum or golden chain (**Laburnum anagyroides**), from the mountain woods of southern Europe, has large pendulous racemes of yellow pea flowers. All parts of laburnum, planted on the Downs, are poisonous, especially the seeds which are attractive to children. American false acacia (**Robinia pseudacacia**) is planted on the Downs and occurs as an escape from cultivation in the North Road area of Leigh Woods. Its similar flowers are white and the pinnate leaves spiny at base.

Bird-sown cherry laurel (**Prunus laurocerasus**) is occasional in Leigh Woods as is similar Portugal laurel (**P. lusitanica**), an occasional shrub on both sides of the Gorge. The former has erect flower spikes and 20 mm black berries; the latter usually pendent flowers and somewhat smaller (8-13 mm) red berries which turn black. Both have been confused with sweet bay. The wild form of cherry plum or Myrobalan plum (**P. cerasifera**) is planted near the top of the Gully as it is in hedges in many parts of England: a very pale pink-flowered form with purple leaves (**P. cerasifera** 'Atropurpurea', **P. pissardii**), well-known in gardens, is widely planted on the Downs. There is a large specimen below St. Vincents Rocks, by the Devon wall. St. Lucie cherry (**P. malhaleb**) was formerly, and may still be, in scrub opposite the Zoological Gardens. **P. x fruticans** (**P. domestica** x **P. spinosa**) would seem to be the correct identity of the wild plum which borders the path following the cliff-edge around Observatory Hill. On the Gorge side it is cut as a hedge but grows unrestricted on the Downs side of the path. The fruit, few of which are borne, is more palatable and rather larger than that of the sloe which it otherwise resembles.



Cotoneaster frigidus   C. microphyllus   C. horizontalis

The cotoneasters, a large group of shrubs and small trees of mainly eastern origin, have had a disastrous impact on the native flora of the Gorge. White, in his Flora (1912), refers to the evergreen rockspray (**Cotoneaster microphyllus**) as 'of great age and evidently not planted' and suggests, undoubtedly correctly, that it was bird-sown. The writer has seen stems up to 14 feet in length cascading over the rocky slopes of the Clifton side of the Gorge where they grew to the total exclusion of all other vegetation in an area formerly rich in specialities of the Carboniferous Limestone. Thankfully this and much wallspray (**C. horizontalis**) has now been largely removed by conservation workers but the latter continues rapidly to colonise quarry slopes and walls on the Leigh Woods side despite the considerable conservation work which has already been undertaken. These species in particular are likely to remain a constant threat to the native flora. Other cotoneasters, which are widely grown as ornamental trees, shrubs and as ground-cover in nearby gardens, have been recorded in the Gorge and include Khasia berry (**C. simonsii**), **C. delsianus**, **C. franchettii** and **C. salicifolius**. Undoubtedly others await identification. The Himalayan tree cotoneaster (**C. frigidus**) can be seen on rocks near the Observatory where it was probably planted and also in



Cotoneaster simonsii C. franchettii C. dielsianus

secondary woodland in quarries in Leigh Woods where it is doubtless bird-sown. The berries of the freely fruiting cotoneasters represent an attractive, extensive and increasing source of food for winter-feeding birds: the impact of these invasive taxa is unlikely to diminish.

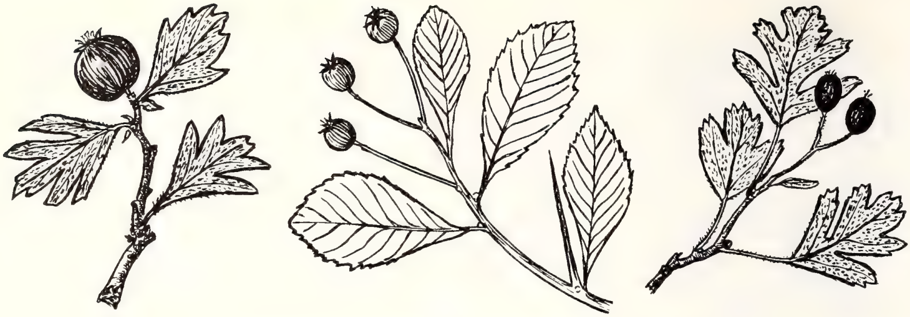
Firethorn (**Pyracantha coccinea**) is bird-sown on a ride in Leigh Woods and, over the river, in the Gully where it is becoming over-run with ivy.

Closely related hawthorn (**Crataegus monogyna**), a feature of the scrub flora of the Downs is a native but has also been widely planted in the past: colour forms abound. Cockspur thorn (**C. crus-galli**) formerly grew under St. Vincents Rocks where it was cut down when the Devon wall was built in 1981; it is also planted on the Promenade near the Mansion House. Both **C. x lavallei** and **C. x prunifolia** (hybrids of the latter) are probably planted. Near the top of the Gully on the Downs, single specimens of **C. nigra** and **C. laciniata** (**C. orientalis**) can be seen: the former, from E.C. Europe, with black pomes and the latter, from S.E. Europe and Spain, with much larger orange-red fruits.

The Avon Gorge is renowned for its whitebeams, a taxonomically difficult group of which at least eleven species or microspecies are known to occur. Apart from two rare endemic species, Bristol whitebeam (**Sorbus bristoliensis**) and Wilmott's whitebeam (**S. wilmottiana**), both of which feature together in a commemorative planting on the Downs, three alien species are known in the area. The service tree of Fontainbleau (**S. latifolia** s.s.), distinguished by its large yellowish fruits, is found near the Great Quarry. Widely planted Swedish whitebeam (**S. intermedia**) is well-known on the tow-path under Leigh Woods and elsewhere. The third alien species, **S. devoniensis** 'Theophrasta', with large orange fruits, derives from the broad-leaved whitebeam (**S. devoniensis**) but is of uncertain origin. It appears to have been widely planted in Britain in the early 20th century: the Bristol trees are believed to have arisen from planted specimens in nearby Sneyd Park. Bristol Corporation has made extensive plantings of whitebeams on the Downs in recent years - a pity perhaps, in view of the close proximity of the indigenous endemic **Sorbus** populations of the Gorge.

Both apple (**Malus sylvestris**) and pear (**Pyrus communis**) are widespread - growing from cores casually discarded by humans.

A single specimen of **Garrya elliptica**, a well-known dioecious, evergreen shrub valued for its dense clusters of pendulous, 6 inch, grey catkins appearing in mid-winter occurs on rocks near the Observatory. The male form and undoubtedly originally planted: the less attractive female form with shorter catkins is seldom encountered except in a few institutions. The N. American family Garryaceae is closely related to Cornaceae, the dogwood family.



Crataegus laciniata **C. crus-galli** **C. nigra**

Japanese knotweed (**Reynoutria japonica**) is commonly naturalised, notably in the vicinity of Clifton Bridge Railway Station where the hybrid with closely related **R. sachalinensis** has recently been recognised. Nearby is Himalayan knotweed (**Polygonum polystachyum**), yet another of these valueless introductions which have become such eyesores in our countryside.

The handsome Huntingdon elm (**Ulmus** x **vegeta**), a hybrid of smooth-leaved elm (**U. carpinifolia**) and wych elm (**U. glabra**), adorns the Downs by Upper Belgrave Road, where three fine specimens stand. First recorded here in 1918, these trees resisted the onslaught of the 1971 strain of Dutch elm disease which largely eradicated our elms. A few walnut trees (**Juglans regia**) grow on the Downs near the top of the Gully.

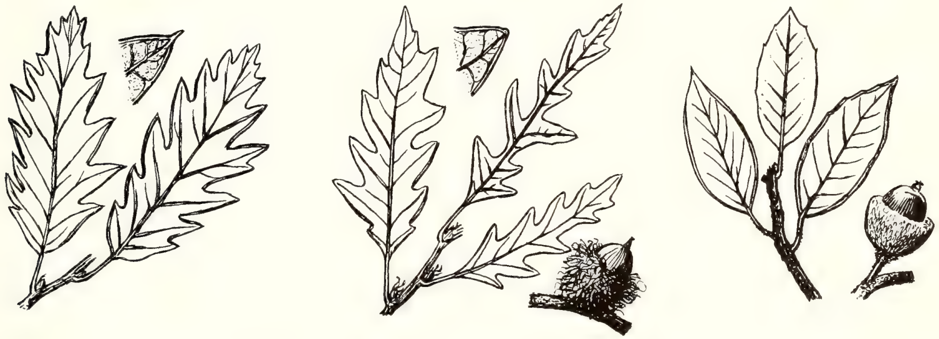
London plane (**Platanus** x **hispanica**), the product of the crossing of oriental plane (**P. orientalis**) and American plane (**P. occidentalis**), is surprisingly rare on the Downs when one considers how widely it has been planted elsewhere in the city. Hornbeam (**Carpinus betulus**), native in eastern England, is of uncertain status here. Its distribution in Leigh Woods, where it is coppiced, centres on the New Plantation. Beech (**Fagus sylvatica**), native as far west as the Wye Valley, has been planted in Leigh Woods where fine specimens can be seen, especially in The Plain. 'Purpurea', the copper beach, is extensively planted in Leigh Woods and on the Downs.

Sweet chestnut (**Castanea sativa**), brought by the Romans to Britain, appears to be an early introduction in Leigh Woods where some very large coppice stools are to be seen.

The oak family has probably had a greater environmental impact on the Avon Gorge than any other group of introductions, with disastrous effect on the flora and a very considerable one on the landscape. The chief offender, S. European holm oak (**Quercus ilex**), was known to White before publication of his Flora in 1912 but, at that time, was unidentified and so excluded. Neither, strangely, does it find a place in the Flora of Gloucestershire (Riddelsdell **et al.**, 1948). Planted first in the Zoological Gardens and on the slopes opposite, it has probably spread with the help of birds from these sites and also possibly from other gardens in the area. The cessation of sheep grazing in 1924 accelerated its rapid advance and helped it to reach pest proportions by the 1950s, but it was not until the mid-1980s that belated attempts to control its spread were undertaken. Sadly, these measures have resulted in unfounded and undeserved criticism from the lay public in the local press. Rapidly growing holm oak is ideally suited to colonise the thin, stony soils of the Gorge; its dense canopy shading out all vegetation beneath it, an effect exacerbated by thick carpets of slowly-rotting fallen leaves.

Shepard (1979) draws attention to its menace on the Isle of Wight, where chalk downland is threatened by holm oak seedlings following establishment on the steep escarpment of St. Boniface Down.

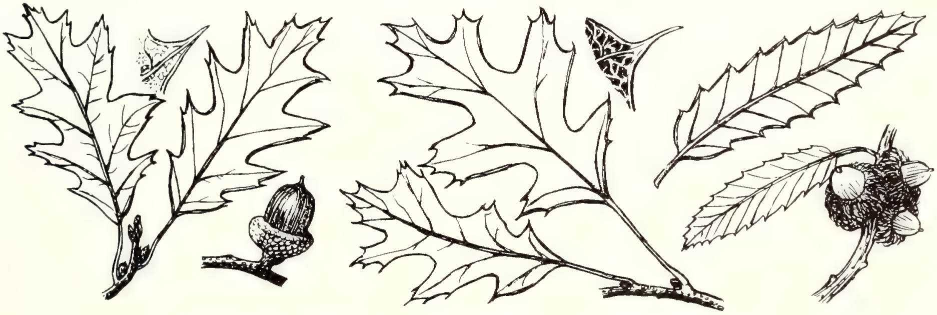
Also of S. European origin but extending further eastwards into S.W. Asia is Turkey oak (**Q. cerris**) which is naturalised in the Avon Gorge and Leigh Woods. The variable dark green deciduous leaves are frequently cut nearly to the midrib although it seldom displays mucronate lobes as does Lucombe oak (Q. x **hispanica**), a hybrid arising from the crossing of **Q. cerris** and cork oak (**Q. suber**), which occurs naturally in S. Europe. A young specimen of this rather uncommon hybrid, which can easily be confused with Turkey oak, may be seen near the Observatory. There are plantings of Lucombe oak elsewhere on the Downs.



Quercus x **hispanica** **Q. cerris** **Q. ilex**

Rapid growing and commercially important, the E.N. American red oak (**Q. borealis**) is a feature of the Forestry Commission plantations in Oak Wood. There is little or no evidence of natural regeneration: what seems at first sight to be saplings in the understorey are merely abundant shoots from earlier thinnings. As its name might suggest, red oak is strikingly coloured in autumn: its leaves vary very considerably in shape and size. Scarlet oak (**Q. coccinea**) is planted on the Downs near the Mansion House. Autumnal colour is even more striking in this species.

Whilst collecting specimens for the illustration of this paper, the writer chanced upon a sixth alien oak species - chestnut-leaved oak (Q. **castaneifolia**) - near the top of the Gully. This extraordinary find involved three or four saplings



Quercus borealis **Q. coccinea** **Q. castaneifolia**

growing amongst blackberry and hawthorn scrub and probably resulting from an animal's or bird's acorn cache. Not only is this species recorded for the first time in the wild in the Bristol area, it is also apparently new to the British Isles. At the moment its provenance is unknown but it must be grown nearby.

Poplars found in Leigh Woods include aspen (**Populus tremula**), which has been coppiced; grey poplar, now considered a hybrid (Meikle, 1975) between the previous species and **P. alba** (= **P. x albescens**) and a Forestry Commission planting of one of the balsam type with serrated, cordate leaves and rusty orange burrs on the trunk. This is probably one of the hybrids between the American eastern and western balsam poplars.

Wild rhododendron (**Rhododendron ponticum**) has been planted in Leigh Woods and, despite the widely-held belief that it is not so prolific on less acid soils (Roe, 1981), it seems rampant now with several impenetrable thickets in evidence. The strawberry tree (**Arbutus unedo**), of the heather family (Ericaceae), is known as single trees from the bottom of the Gully, and a quarry under Leigh Woods.

Handsome buddleia or 'butterfly bush' (**Buddleja davidii**), now such a major feature of the Bristol flora, has spread to rocky and waste places throughout the Gorge since its first record in Bristol in 1930 when it was recorded as established by the Avon under Leigh Woods. It was probably originally self-sown rather than planted.

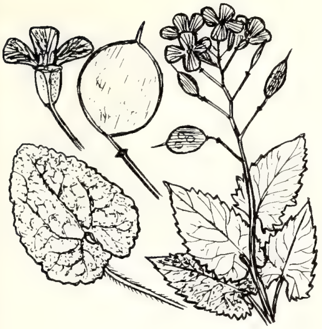
The garden privet (**Ligustrum ovalifolium**) is locally established in Burwall's Wood, probably rooted from discarded hedge trimmings. Another hedging plant, **Lonicera nitida**, a honey-suckle from China, escapes occasionally and is found in this wood and in the North Road area. The Himalayan honey-suckle (**Leycesteria formosa**) and snowberry (**Symphoricarpos rivularis**) are both established in Leigh Woods. Bushy, evergreen larustinus (**Viburnum tinus**), another garden favourite, has become extensively naturalised on St. Vincents Rocks and elsewhere in the Gorge. Yet another serious threat to the native flora which has been a recent target of the conservation workers: a native of S.E. Europe flowering in the winter months.

HERBACEOUS SPECIES

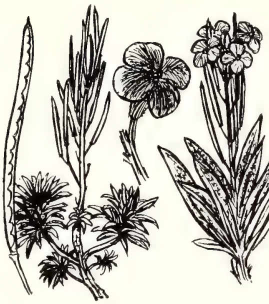
Welsh poppy (**Meconopsis cambrica**), native in a few localities in Somerset, is merely a garden escape in Leigh Woods below North Road; orange-flowered **Papaver atlanticum**, a favourite in old gardens, occurs as a casual in this area. Both are perennials. The annual opium poppy (**P. somniferum**) is a frequent weed of disturbed ground; a striking scarlet form was abundant on the Devon wall under St. Vincents Rocks for a few years and occasionally since.

The much-confused crucifers wild turnip (**Brassica rapa**) and rape (**B. napus**) both occur as casuals but the latter is much more frequent. Horse radish (**Armoracia rusticana**) has occurred occasionally on imported soil and persists. In early spring the white flowers of garden arabis (**Arabis caucasica**) cascade over St. Vincents Rocks from a rockery on the Suspension Bridge approaches. The white form of dame's violet (**Hesperis matronalis**) may be found in a few spots in Leigh Woods. Honesty (**Lunaria annua**) is extensively established on St. Vincents Rocks where its bright purple hue contrasts with the deep yellow of wallflower (**Cheiranthus cheiri**) and contributes to a blaze of colour. Frequent plantings of the wallflower (gilly-flower) have been made over the years by misguided folk with intentions of beautifying the Gorge; it has been known hereabouts since 1866.

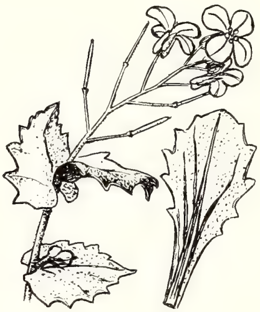
Rose of Sharon (**Hypericum calycinum**), an escape or sometimes a garden throw-out, is known in several places in Leigh Woods. Corn cockle (**Agrostemma githago**), once a widespread weed of arable land but on the verge of extinction now in Britain, was recorded on the verge of the Portway near the Horseshoe



Lunaria annua



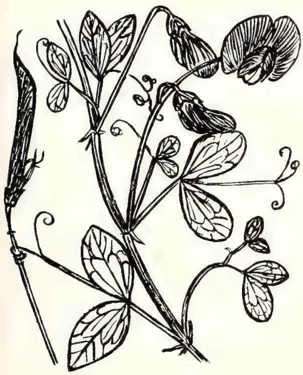
Cheiranthus cheiri



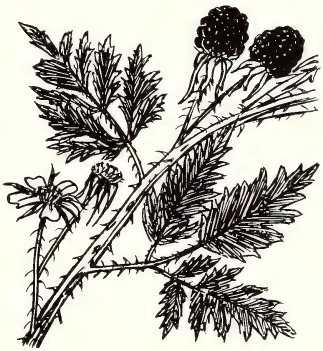
Arabis caucasica

Bend in 1977. Within a few years the population had risen to 42 plants, but its decline was as spectacular as its increase and in 1985 only two plants remained. It has not been seen since. Nearby dusty miller, perhaps better known as snow-in-summer (**Cerastium tomentosum**), grows in great quantity on road banks. The man-made common flax (**Linum usitatissimum**) is seen in most years either bird-sown or spilled from lorries on the Portway. Himalayan balsam (**Impatiens glandulifera**) occurs throughout the Gorge: it has been known in the Trym valley for over a century.

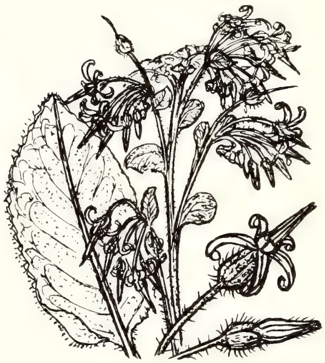
Tall melilot (**Melilotus altissima**) is abundantly naturalised on the tow-path under Leigh Woods. Its pubescent young pods separate it from common melilot (**M. officinalis**), with glabrous young pods, which occurs on waste ground. Common vetch (**Vicia sativa**) is found on roadsides and railway embankments: the latter habitat is favoured by everlasting pea (**Lathyrus latifolius**). Spectacular **Lathyrus grandiflorus** with flowers up to 3 cm in size, the standard violet, wings purple and keel pink, is extensively naturalised on the site of the old Clifton Bridge Railway Station at the bottom of Rownham Hill. A very few plants are also to be seen by Christchurch on Clifton Down.



Lathyrus grandiflorus



Rubus laciniatus



Trachystemon orientalis

Two alien species of blackberry grow in the Gorge - the familiar cultivated **Rubus procerus** is abundant on the tow-path and elsewhere and **R. laciniatus**, with attractive, deeply cut leaves, has a single site in the Gully. Sulphur cinquefoil

(**Potentilla recta**), with large pale yellow flowers and palmate leaves, is naturalised on a road verge on the Portway near the Horseshoe Bend. Fodder burnet (**Poterium polygamum**), formerly cultivated for fodder, is also found beside the Portway in several spots.

The Gorge provides an ideal habitat for stonecrops: Caucasian (**Sedum spurium**), white (**S. album**) and reflexed (**S. reflexum**) are all naturalised on or near St. Vincents Rocks.

The umbellifer Alexanders (**Smyrnium olusatrum**), formerly used as a pot herb in Britain and probably introduced by the Romans, is widespread and abundant throughout, especially on the Downs; garden parsley (**Petroselinum crispum**) grows on rocks near the Suspension Bridge, its identity sometimes betrayed by the more or less crisped leaves characteristic of the cultivated plant. Ground-elder or goutweed (**Aegopodium podagraria**), a woodland native of much of Europe and Asia but considered mainly introduced in Britain, is present in great quantity along some paths in Leigh Woods. Formerly grown as a pot-herb, it is now a widespread and troublesome weed.

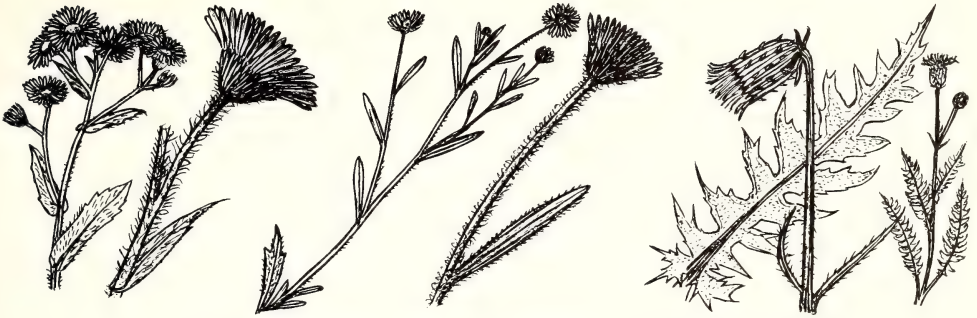
Red-veined dock (**Rumex sanguineus** var. **sanguineus**), formerly cultivated for medicinal purposes, is still sometimes seen on or near the Zig Zag.

Variously pink to reddish-coloured primroses, encountered in the Gorge from time to time, probably result from the pollination of the wild primrose (**Primula vulgaris**) by forms of the garden hybrid **P. juliae** x **P. vulgaris** (the well-known **Primula** 'Wanda'). Cyclamen or sowbread (**Cyclamen hederifolium**) flowers in the N.W. corner of the Downs if the grass is not mown first! The yellow loosestrife (**Lysimachia punctata**) is a frequent garden outcast and may be seen as such in Leigh Woods.

Borage (**Borago officinalis**), widely cultivated as a herb, occurs occasionally but seldom far from human habitation; green alkanet (**Pentaglottis sempervirens**) is plentiful in the vicinity of Leigh Woods Village and also grows about Cook's Folly Wood, where its strangely-named E. European relative Abraham, Isaac and Jacob (**Trachystemon orientalis**) has recently been found. This rather uncommon alien flowers early, before the leaves. Common lungwort (**Pulmonaria officinalis**), also a woodland plant, grows under Burwall's Wood.

Common snapdragon (**Antirrhinum majus**) is a colourful feature of the rocks of the Gorge where, according to White, it has been established from 'time immemorial'. Its relative, purple toadflax (**Linaria purpurea**) also has a long history in the Gorge: pink-flowered forms occur occasionally. Dainty slender speedwell (**Veronica filiformis**), a native of the Caucasus and N. Anatolia which was first introduced into Britain as a rockery plant in the 1860s and is now a permanent feature of our lawns, occurs throughout the area. It sets no seed in Britain but the tiniest fragment of its tissues will root with the greatest of ease.

Colourful and long-flowering red valerian (**Centranthus ruber**) is another long-standing introduction adorning the rocks of the Gorge. 'Albus', the white form, is also present. Silver ragwort (**Senecio cineraria**), prized by gardeners and florists for its foliage, has been recorded under Leigh Woods on the tow-path where **S.** x **albescens**, its hybrid with common ragwort (**S. jacobea**), is also known. Ubiquitous Oxford ragwort (**S. squalidus**) abounds on roadsides and disturbed soil. Winter heliotrope (**Petasites fragrans**) flowers in December and January under Black Rocks. Two similar alien species of goldenrod occur extensively in the Gorge in neglected areas. **Solidago gigantea** is the commonest and flowers several weeks before the better-known **S. canadensis**, the commonly grown garden plant. St. Peter Port Daisy, so-named because of its abundance on Guernsey walls, may be more widely known as Mexican fleabane (**Erigeron karvinskianus**): it is rather local



Erigeron philadelphicus **E. karvinskianus** **Cirsium erisithales**

in the Gorge where it favours south-facing rocks. Feverfew (**Chrysanthemum parthenium**) is widespread and Shasta daisy (**C. maximum**) grows near the Clifton Bridge station where it is a relic of cultivation. The yellow melancholy thistle (**Cirsium erisithales**), a montane plant of C. Europe, seems quite at home in the Nightingale Valley, Leigh Woods where it has been known for nearly a decade since it escaped from the University Botanic Garden. From the same source is the garden-worthy N. American Philadelphia fleabane (**Erigeron philadelphicus**) with long pink ligules which is encountered in North Road from time to time. An early record of significance was that of Canadian fleabane (**Conyza canadensis**) made by Withering from St. Vincents Rocks in 1796. White (1912) wrote of this now ubiquitous weed '... no doubt an interloper, and a rare one, for this alien seems to hold aloof from the strangers that spring up about our docks and rubbish heaps. I have met with but few specimens during my residence in the city'. Blue sow-thistle (**Cicerbita macrophylla**), formerly a garden favourite, is naturalised in a wood border on the Downs by the Promenade.

Day lily (**Hemerocallis fulva**) grows by the Sea Walls and also in scrub beside the Portway. Asparagus (**Asparagus officinalis**) has been known for nearly 300 years from saltmarsh on both sides of the river. Solomon's seal (**Polygonatum** x **hybridum**), the garden hybrid of our two native species, has been recorded from several spots in Leigh Woods. In nearby North Road, on a road-verge, the Star of Bethlehem (**Ornithogalum umbellatum**) is a blatant garden escape. In Cook's Folly Wood, over the river, butcher's broom (**Ruscus aculeatus**) is planted. The garden or Spanish bluebell (**Hyacinthus hispanicus**), which bears scant resemblance to the wild plant of that name, is frequent.

Insignificant slender rush (**Juncus tenuis**) was first recorded on the tow-path and on paths in Leigh Woods above as long ago as 1914. It is now widespread in the quarries and on the woodland rides.

Three or four flower heads of keeled garlic (**Allium carinatum**) were noted on the Downs near the Observatory in 1904: in 1911 there were at least twenty. By 1972 the figure had risen to 3,000 and it is doubtless much higher today. But keeled garlic is no longer confined to this small area of Clifton Down - it has now been recorded as far away as the Sea Walls on Durdham and has also found its way over the river and has been recorded in several localities in Leigh Woods and on the tow-path below. Rosy garlic (**Allium roseum**) was first recorded from Observatory Hill at the same time; it is now thoroughly established from the top to the bottom of the Gorge but does not seem to have spread further. Unlike the previous species, rosy garlic is an attractive plant and it must be said that it imparts considerable colour to the cliffs in late spring. A third species of wild onion, **Nectaroscordum siculum** (**Allium siculum**), was first noticed on nearby St. Vincents Rocks in 1906. When first known to the writer, the site was overgrown with rank vegetation and no more than half a dozen flower heads were to be seen each year. Following scrub clearance in 1985, however, over forty heads appeared - tribute indeed to the persistence of this species!

That all three species were originally planted has never been in any doubt but by whom they were planted was a different matter. It was not until 1917 that a science teacher at Clifton College, one G.H. Wollaston, 'confessed to Miss Roper' that he had planted **A. carinatum** there in 'about 1897'. (The quotes are annotations in White's own copy of his Flora, the first made by White himself and the second by Miss Roper, another eminent Bristol botanist and close friend of White). Wollaston had **N. siculum** in his garden in 1907 (having apparently collected it himself in Sicily) and there can be no real doubt that he planted this, **A. roseum** and **A. carinatum** as well. Why is another matter. What motivates such apparently otherwise intelligent people to commit such mischievous acts?

Elsewhere on Clifton Down the daffodil (**Narcissus pseudonarcissus**) has been planted but is unlikely to make the same impact as the preceding species. The London flag (**Iris germanica**) is a well-established and increasing relic of gardens of the long-defunct Hotwells Railway Station: it is accompanied by colourful red hot poker (**Kniphofia** cf. **uvaria**), another old garden favourite. Crocuses, planted and naturalised here and there on the Downs, probably belong under **Crocus purpureus** and **C. tomasinianus**.

The only introduced grasses of importance in the Gorge are Townsend's cord-grass (**Spartina** x **townsendii**) and its fertile derivative **S. anglica**, formed naturally by chromosome doubling. The former was introduced into the Severn estuary some 70 years ago for stabilisation of mud banks and has spread up the Avon as far as Hotwells since that time. Annual vernal-grass (**Anthoxanthum puelii**), which appeared in some quantity after the planting-up of the gallery roof under St. Vincents Rocks, persisted for just two years and was then lost. Otherwise only a few bird-seed or grain alien grasses such as canary-grass (**Phalaris canariensis**), the digitate hairy finger-grass (**Digitaria sanguinalis**) and bristle-grass (**Setaria viridis**), which are seen on the Portway in most summers, are worthy of mention.

ACKNOWLEDGEMENTS

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THE GEOLOGY AND THE EVOLUTION OF THE AVON GORGE

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ABSTRACT

The paper looks at the Avon Gorge at two scales; first at the regional scale to examine the way in which the scenery of the Bristol region evolved through geological time, but focussing on the River Avon, and especially the Gorge at Clifton; while the second scale summarises the environments in which the rocks exposed in the Gorge were deposited by making a transect upstream.

INTRODUCTION

The unusual course of the Bristol Avon and its progress through alternate gorges and lowlands have given rise to perplexity and much speculation in the past. Although both authors have written previously on the subject (Bradshaw, 1966; Frey, 1975) now is an opportune time to summarise the genesis of this puzzling yet key river and to show how the Clifton Gorge, by cutting through an ancient anticline, exposes a wide variety of different lithologies which in turn give rise to a series of different environments.

It is impossible to do justice to, or even to understand, the complexity of the present day river and the scenery through which it runs, without unravelling the major events in geological time which generated the landscape of today.

THE TWO CYCLES

For lowland Britain in particular, the Bristol district possesses a highly distinctive and strongly contrasted scenery, acknowledged by the significant proportion of it which is designated to be of high landscape value. This distinctiveness is accountable to two principal circumstances in the geological history of the region, both of which have been played upon by erosion in the later Cainozoic era. The first factor is the great lithological variety of the local strata, bringing together durable and weak beds, some porous and some impermeable, each of which responds differently to erosional forces.

The second factor is that most of the rocks of the district belong to either one or another of two principal and well separated "cycles", between which is a major unconformity (see Table 1). Of course, condensing a hugely complex geological history into such a simple format runs the risk of trivialising it and can only be justified as a first approximation because the rocks of the Bristol region can be clearly recognised as belonging to one or other of the two 'cycles'. Such a simplification ignores any evidence of pre-Devonian rocks and movements, as seen for example in the Tortworth inlier, but is justified because such elements form such a small, though interesting part of the surface geology of the district. Similarly, there were minor cycles contained within these two major events, notably within the Jurassic and the early Cretaceous, but again, they do not obscure the recognition of the two great cycles.

It can be seen from Table 1 that each cycle begins with an episode characterised largely by deposition[1], to be followed by an episode when earth movements (diastrophism) predominate, finally to be succeeded by a third phase when erosion becomes the major activity. Of course these episodes overlap so that, for example, Hercynian movements began quite early in the Carboniferous and interrupted the depositional process, but the major movements came towards the end of this period [see Kellaway & Hancock (1983) for a comprehensive account of tectonics in the Bristol region].

THE FIRST CYCLE

Taking the first cycle on Table 1, we can see that Devonian and Carboniferous times saw the accumulation of some 5000 m of sediment, comprising the deltaic sandstones of the Devonian, followed by the massive beds of the Carboniferous Limestone, and then overlain by the alternating sandstones, clays and coals of the Pennant Sandstone and Coal Measure series. This was the first, the dominantly depositional phase, of the cycle. It was followed by the second phase

TIME

	DOMINANT ACTIVITY	TIMING
First Cycle	a) Deposition	Devonian and Carboniferous
	b) Diastrophism	Hercynian (Variscan) Late Carboniferous - early Permian
	c) Erosion	Permian and Triassic[2]
------ Major Unconformity ------		
Second Cycle	a) Deposition	Jurassic and Cretaceous
	b) Diastrophism	Late Cretaceous to the Miocene, but culminating in the Oligocene
	c) Erosion	Intermittently throughout the Tertiary and especially in the Quaternary

TABLE 1 The two cycles.

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[1] Deposition in a part of our region must obviously be supplied by erosion from somewhere else inside or more usually outside the region and vice versa. In the Permo-Triassic there is the added difficulty that, at the same time that the anticlinal crests were being eroded, erosional products were accumulating on their flanks and in the downfolds and basins.

[2] In both these periods, active erosion of higher ground led to substantial deposition around the upland masses, so that this phase is characterised as dominantly erosive only so far as the uplands are concerned.

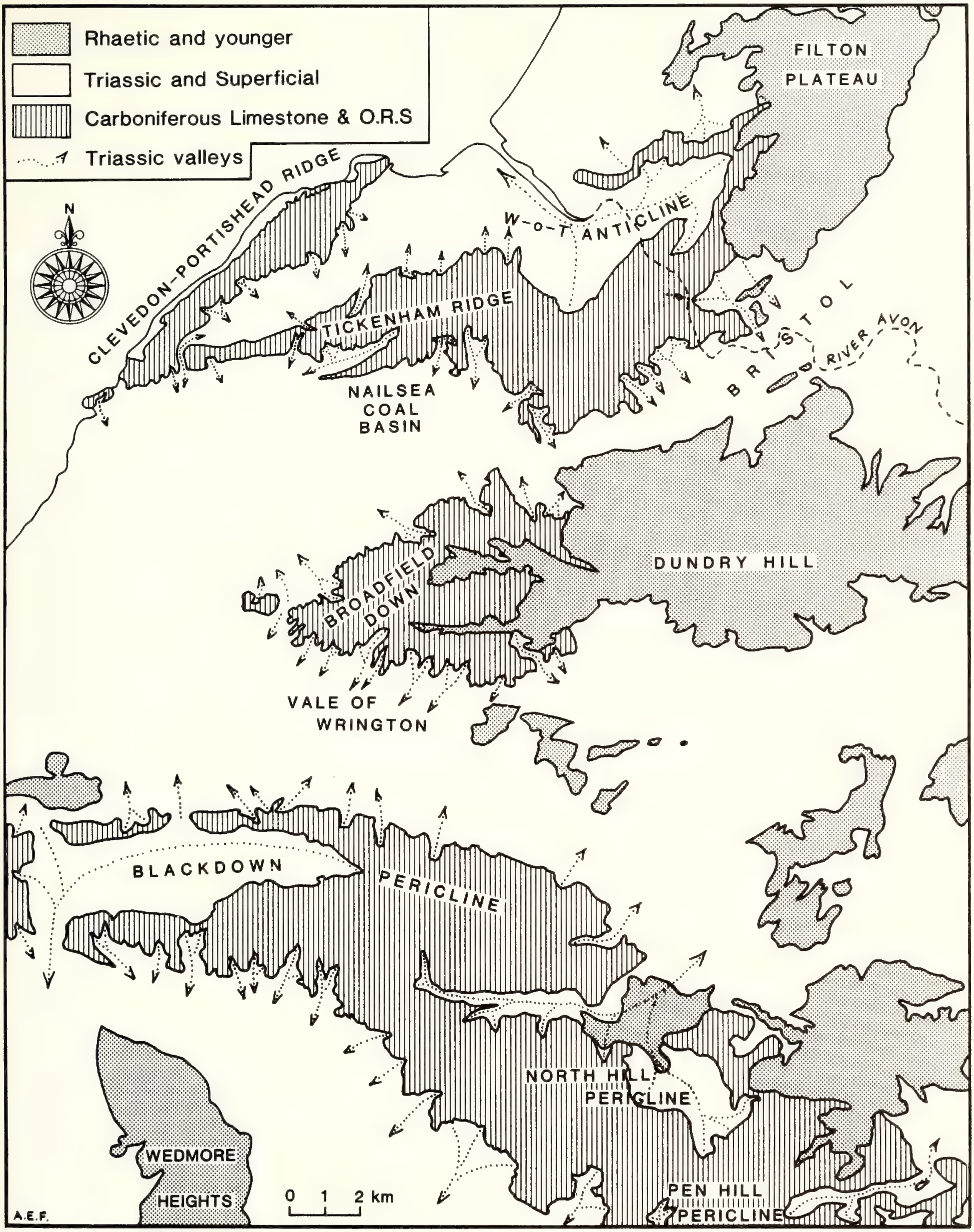
Rhaetic and younger
Triassic and Superficial
Carboniferous Limestone & O.R.S
Triassic valleys
N
CLEVEDON-PORTISHEAD RIDGE
W-o-T ANTICLINE
FILTON PLATEAU
TICKENHAM RIDGE
NAILSEA COAL BASIN
BRISTOL
RIVER AVON
BROADFIELD DOWN
DUNDRY HILL
VALE OF WRINGTON
BLACKDOWN PERICLINE
NORTH HILL PERICLINE
WEDMORE HEIGHTS
0 1 2 km
PEN HILL PERICLINE
A.E.F.

FIGURE 1 A reconstruction of the valley pattern of late-Triassic time.

in which Hercynian earth movements predominated, an episode which overlapped the end of the Carboniferous and ran on into the Permian, causing the horizontally laid sediments to be thrown into a series of folds. The mechanisms of folding have been re-examined in an important paper by Williams and Chapman (1986) who propose that "... the Mendip-Bristol area represents a thin-skinned foreland thrust belt of Variscan age... with the dominant direction of thrust movement from south to north." They identify and label six major piggy-back thrusts, of which the southerly four involve the creation of the four Mendip periclines, the Broadfield Down anticline, and the Tickenham/Kingswood anticline, all responsible for folds with east-west alignments. The two most northerly thrusts however, were likely influenced by powerful ancient fold and fault axes in the underlying basement rocks, especially the Bath but also the Lower Severn Axis, so that the thrusts, along with the folds to which they give rise, are aligned much more on either NE-SW lines (the Westbury-on-Trym anticline and the Avonmouth coal basin syncline) or on N-S lines (the N. Bristol coalfield syncline, and the Forest of Dean syncline). The map on p.64 of their paper illustrates these dispositions very clearly.

Even as they were in the making, these folds began to be attacked and eroded by the river systems of the time, so ushering in the third and final phase of the first cycle. This period, the 70 million years from the late Carboniferous to the beginning of Jurassic times, was probably the longest and also the most sustained period of sub-aerial erosion and deposition that "Britain" has ever experienced. It was also an episode characterised by generally very arid conditions, containing periods of acute desiccation with wide-spaced storm intervals and other periods when the return interval of storms could have been very much shorter. The net effect of this attack was eventually to strip off some 2,500 m of the less resistant Coal Measure series from all the anticlinal crests and, in some cases, the whole of the Carboniferous, and to dump the erosional products into the deep downfolded synclinal basins which surrounded them, some at a considerable distance. The Somerset basin, illustrated by Green and Welch (1965) and lying to the south of the Mendip Hills, is estimated to be at least 1,000 m deep and carries a great thickness of Devonian and Carboniferous-derived detritus beneath the present day Jurassic surface rocks. To the north of the Bristol area lay the Midlands basins eventually, in later Triassic time, filled by extensive ephemeral lakes and evaporite deposits. Once the anticlinal crests had been stripped down to expose the Carboniferous Limestone series the rate of denudation would have slowed. Even so, there are enough examples where even the limestone has been removed to expose the Devonian sandstone cores of the anticlines, at which stage the rate of removal would have stepped up sharply again.[3]

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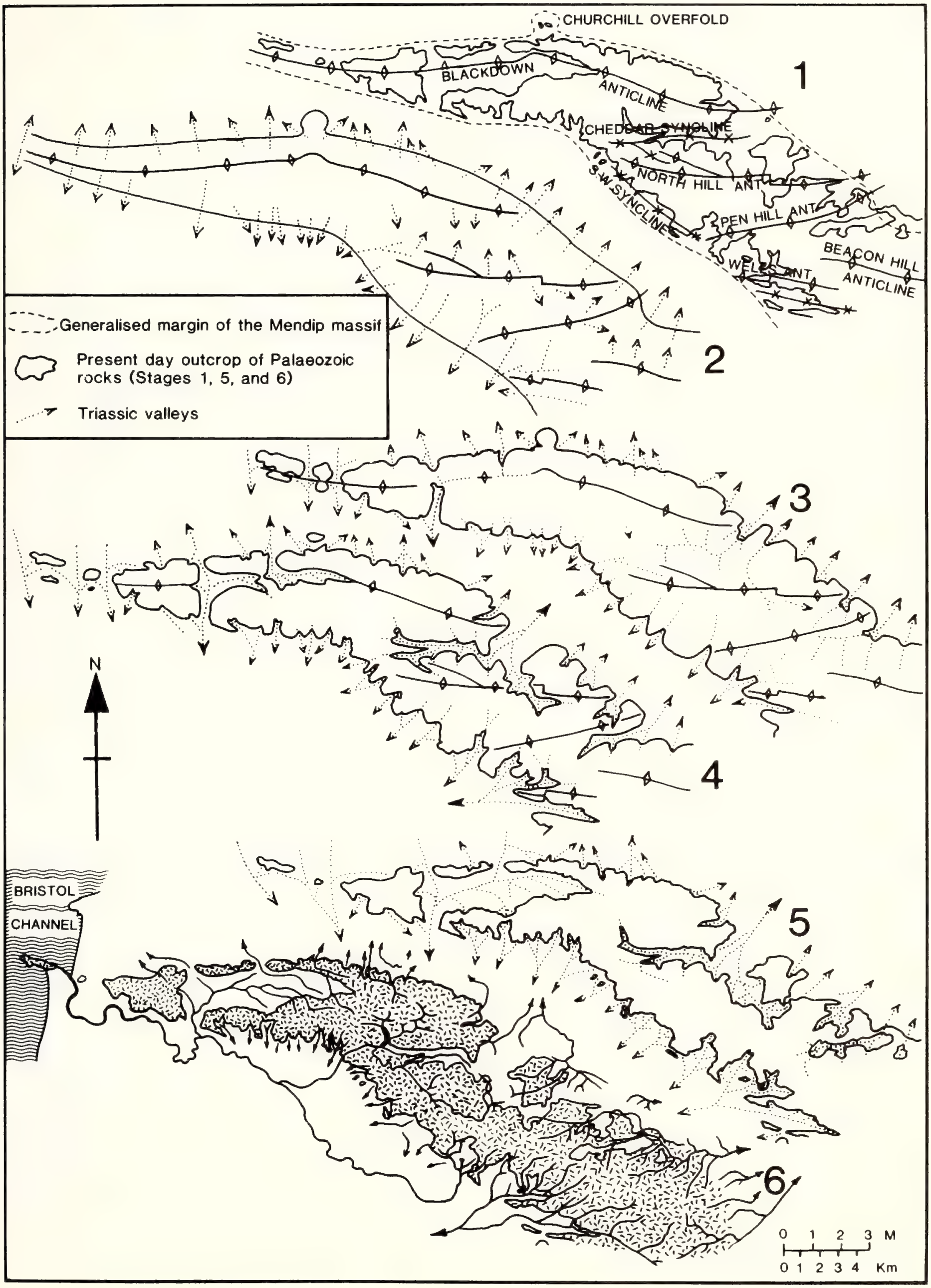
[3] Under arid conditions, limestone succumbs much more slowly than sandstone to erosional attack.

FIGURE 2 (Opposite) Suggested stages in the evolution of the Triassic valley pattern of the Mendip Hills.

Stage 1	shows a generalised margin to the Mendip massif; the present-day outline of the Palaeozoics and the principal fold axes.
Stage 2	illustrates the likely nature of the initial stream pattern following structural slopes.
Stages 3 & 4	show how the pattern might have evolved.
Stage 5	represents the pattern in the late Triassic just before submergence and "fossilisation". It is also therefore the pattern we see today.
Stage 6	The present-day valley pattern. Comparison with Stage 5 reveals that it is only the Cheddar system, of Pleistocene origin, that differs substantially from the Triassic pattern.

Towards the end of Triassic time these anticlines typically showed a valley pattern which consisted of two main elements. There were deep wadi-like valleys at right angles to and dissecting the outer structural slopes of the anticlines,


CHURCHILL OVERFOLD
1
BLACKDOWN
ANTICLINE
CHEDDAR SYNCLINE
S.W. SYNCLINE
NORTH HILL ANT
PEN HILL ANT
BEACON HILL ANTICLINE
WELLS ANT
2
Generalised margin of the Mendip massif
Present day outcrop of Palaeozoic rocks (Stages 1, 5, and 6)
Triassic valleys
3
4
N
BRISTOL CHANNEL
5
6
0 1 2 3 M
0 1 2 3 4 Km

most often filled with angular to sub-rounded gravitational material waiting to start or to continue the journey out into the flanking basins when the next storm provided the means. Secondly, the interiors of some of the more heavily eroded anticlines were occupied by subsequent (longitudinal or strike-orientated) valleys whose ephemeral flash floods were the main agents of the unroofing process. The Mendip Hills (Blackdown in particular) show these elements most clearly (Figure 1), with the so-called Dolomitic Conglomerate acting as a marker deposit of the denudational process. The Dolomitic Conglomerate which plugs valleys and mantles the slopes of this old landscape is an amalgam of gravity deposits, scree and short distance transported material which varies in size from fines to boulders of several tonnes, with much of the contained material aligned downslope and sub-rounded by both solution and transport. So clear in fact is this evidence that it allows us today to build up a possible sequence to the valley pattern of the time, 70 million years ago (Figure 2). Although the extent of the erosion was considerable, it is nonetheless surprising, given the length of the attack and the amplitude of the Triassic relief (masked today by so much later infilling by Jurassic and later deposits), that this folded landscape was not more effectively peneplaned (or rather, given the arid conditions, pediplaned) and it can only be that the attack was blunted by the extreme aridity. The efficiency of this attack was also spatially quite variable too, with generally greater dissection in the west rather than the east of our region. The heavily disturbed major anticlinal feature between Exmoor and South Wales was very effectively eliminated, while the anticlines of western Blackdown and Westbury-on-Trym had their cores eaten out and their relief reversed. Between them however, the Broadfield Down anticline has its limestone roof still in place, so that Bristol's airport is on the Black Rock Limestone near the base of the Carboniferous, rather than upon the Devonian Old Red Sandstone. In eastern Mendip, the crest of the Beacon Hill pericline, although penetrated even to the Silurian, carries no Dolomitic Conglomerate-plugged valleys in or around its anticlinal core and we must presume that the upper Carboniferous cover rocks persisted here much longer and were eliminated by later planation. To anticipate, this forms an interesting parallel with the differential removal of the much later Jurassic cover rocks in the erosional phase of the second cycle, a process still far from complete as we will see.

THE SECOND CYCLE

This third phase of the first major cycle was brought to an end by the progressive incursion of the Rhaetic seas and the beginning of the huge depositional sequences which followed, to form the first phase of the second major cycle. Although there is uncertainty about the margins of the seas in which Jurassic and Cretaceous deposits were laid, there is no doubt that the Bristol region saw discontinuous but massive accumulation of these deposits such that the ancient folded and eroded Palaeozoic landscape was buried and effectively fossilised, not to re-emerge until exhumed by erosion in relatively recent geological time.

This first phase of the second cycle moved into the second phase when, towards the end of the Cretaceous and building up by successive episodes into the Miocene, earth movements of the Alpine orogeny were responsible for tilting the rocks of the region down towards the east and for folding the Jurassic/Cretaceous deposits along generally east-west axes. While it is easy to recognise these folds to the east of the Bristol district in the eroded anticlines of the vales of Pewsey, Warminster and Wardour (Figure 3), the corresponding deposits which mantled the Bristol district of that time have now largely been eroded away, their folds with them. The folded Palaeozoics underneath probably acted as a fairly rigid basement

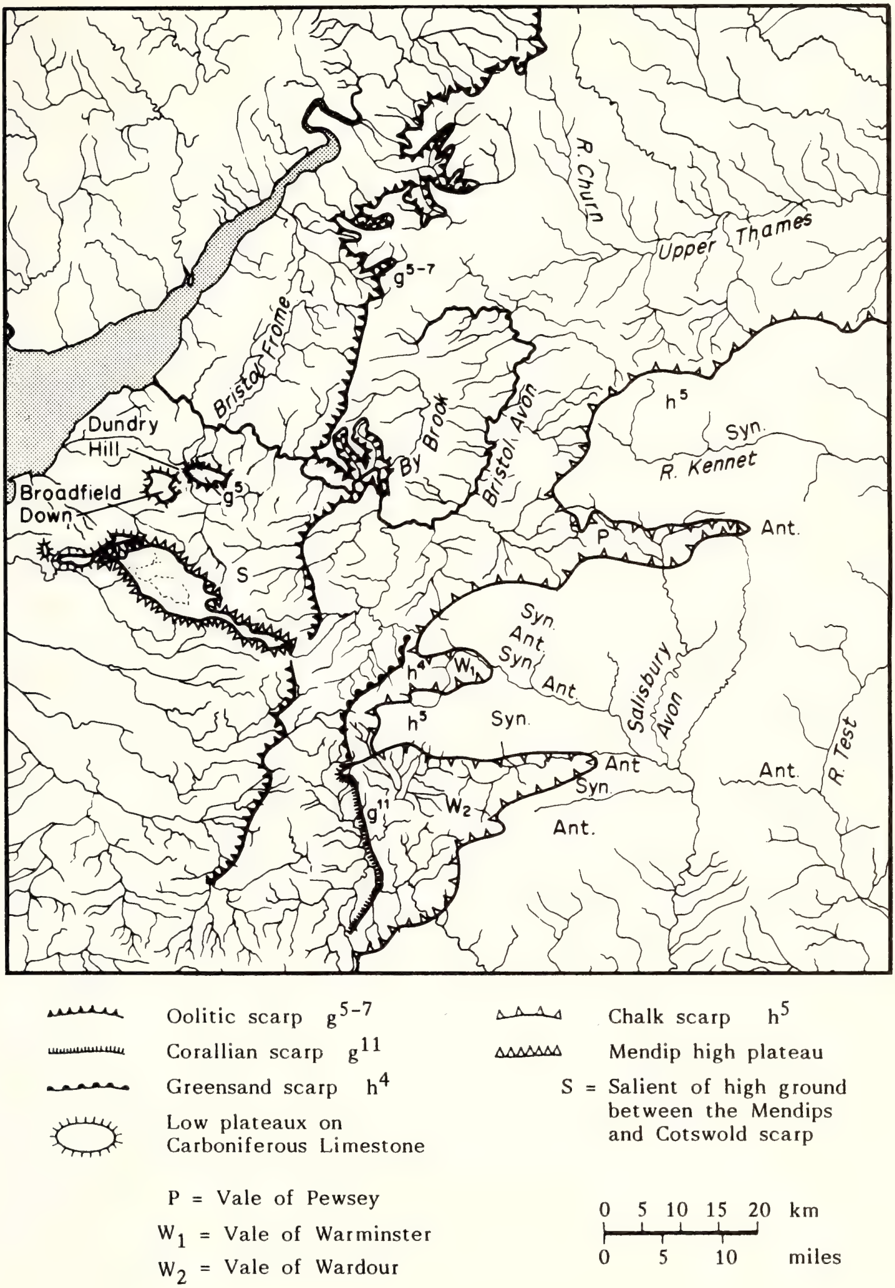

R. Churn
Upper Thames
g5-7
Bristol Frome
By Brook
Bristol Avon
h5
Syn.
R. Kennet
Dundry Hill
Broadfield Down
g5
S
P
Ant.
Syn.
Ant.
Syn.
Ant.
h4
W1
h5
Syn.
Salisbury Avon
R. Test
Ant
Syn.
Ant.
g11
W2
Ant.
Oolitic scarp g5-7
Corallian scarp g11
Greensand scarp h4
Low plateaux on Carboniferous Limestone
Chalk scarp h5
Mendip high plateau
S = Salient of high ground between the Mendips and Cotswold scarp
P = Vale of Pewsey
W1 = Vale of Warminster
W2 = Vale of Wardour
0 5 10 15 20 km
0 5 10 miles

FIGURE 3 Bristol region river pattern showing the three dominant elements: to the Thames, the Severn and the English Channel, and the main escarpments.

to such movements so that they bear little specific trace that can with certainty be recognised today, though the relative altitudes of the various anticlinal crests (Mendip, Broadfield Down, Clevedon/Tickenham, etc) were altered by fold tightening and regional warping.

Although they occupied a long time period, the early to mid-Tertiary folding and warping movements effectively ended the long Jurassic/Cretaceous submergence and once again made a land surface available for sub-aerial attack. Thus the second cycle passed from its depositional phase through its diastrophic phase into the third phase in which erosion became dominant, and this phase has lasted until today. The net effect of this Tertiary and Quaternary erosion has been to drive back the successive escarpments of the scarp-forming rocks within the Jurassic and Cretaceous cover in an easterly direction. At first, the river pattern over much of "England" was likely to have been a southwards flowing one, but this was progressively disrupted by scarpland captures to form a dominantly eastward flowing series of trunk rivers with strong south-flowing tributaries, the remnants of the previous system. Over the whole of southern England and southern Wales these two river orientations can be seen.

THE TWO SCENIC PROVINCES OF THE BRISTOL REGION

Around Bristol the eastward retreat of the scarp fronts has meant that the region now displays two very clearly defined provinces; the gently dipping Mesozoic scarpland country in the eastern half of the region, dominated by the limestones of the Jurassic, and the sharply folded, disinterred, Permo-Triassic-moulded Palaeozoic landscape in the western half (see Figure 4).

Now it is also true that the drainage patterns in these "new" (eastern) and "old" (western) provinces of the region are strikingly different. The 'new' province is dominated by components which have an orientation WSW to ENE towards the upper Thames whose headwaters they once were (Figure 5b). The 'old' province, in contrast, is dominated by streams which flow north-westward into the Severn Estuary (Figure 5a). What makes the Bristol Avon such an interesting key to the evolution of the region's scenery is that it flows through both provinces, its headwaters setting off eastwards down the Cotswolds dip slope to join the Thames but diverted by river capture successively south along the Oxford Clay vale and then north west through the Jurassic escarpment at Bath to run across the grain of the old Palaeozoic landscape to its mouth on the estuary. Indeed, the Avon sits astride the Cotswold escarpment and is simultaneously one of the causes of its retreat as well as a principal source of evidence on the process of retreat, in a battleground which is constantly shifting eastwards and so revealing ever more of the ancient landscape which lies buried beneath. The delight of the Bristol district, which it shares with Charnwood Forest in the east Midlands, is that this Palaeozoic landscape emerging from beneath the Jurassic scarps, instead of being, as it so often is elsewhere, a rather dull and monotonous Triassic plain, is a crisply folded and diversified landscape of great scenic interest.

We have to remember that this 'old' landscape of the Bristol region has been acted upon by marine and by fluviatile erosion many times since it was first fashioned by the arid processes of Permo-Triassic times. We can divide up these erosional episodes into two time groups. The first was in early Jurassic time associated with the incursion and final drowning of the 'old' landscape by the rising sea levels which brought the Triassic to an end. These Rhaetic and Liassic seas, whch were the first to lay down sediments in the old landscape, accomplished some planing-off of the folded Carboniferous rocks as can be seen in the marine-bored surfaces of the spectacular Mendip unconformities at, for

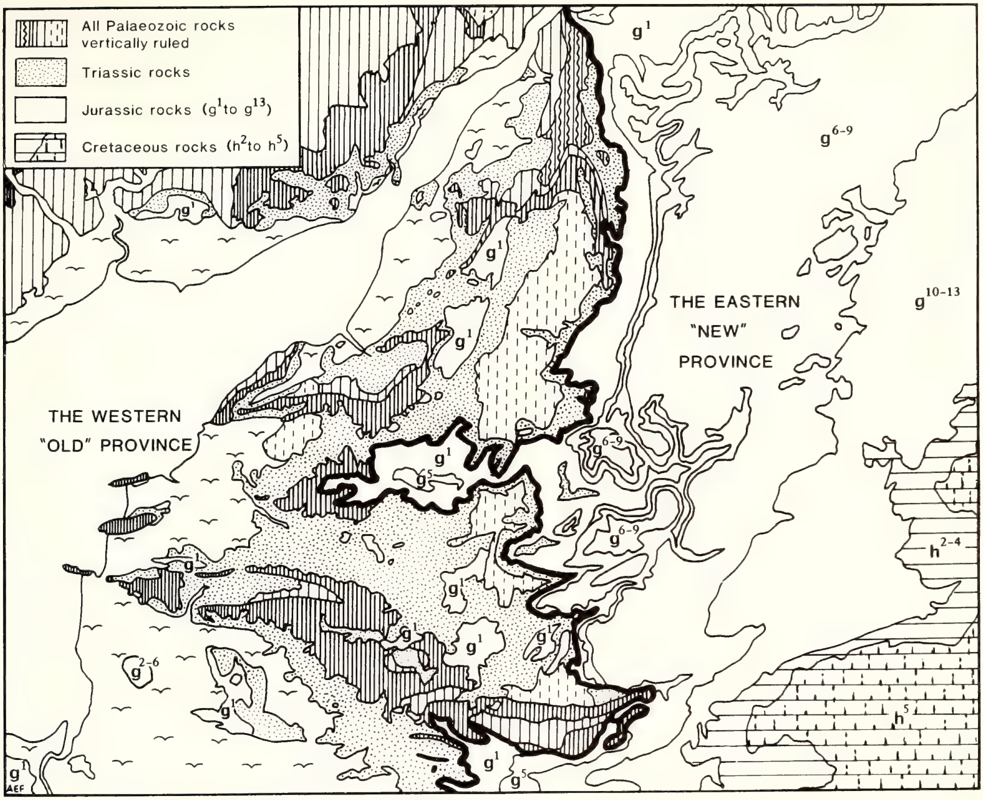

All Palaeozoic rocks vertically ruled
Triassic rocks
Jurassic rocks (g1 to g13)
Cretaceous rocks (h2 to h5)
THE WESTERN "OLD" PROVINCE
THE EASTERN "NEW" PROVINCE
g1
g5
g6-9
g10-13
g2-6
h2-4
h5
AEF

FIGURE 4 Showing the geological elements of the Bristol region divided between "new" and "old" provinces (outliers ignored).

example, Vallis Vale where Inferior Oolite (g^5) rests directly upon Carboniferous Limestone (d^2). Indeed the Mendip summit and Broadfield Down, although at very different heights (300 and 175 m respectively) both show the remnants of Liassic cover rocks, silicified into the Harptree Beds, resting upon their eroded plateau surfaces. It has already been remarked that Beacon Hill in the east Mendip may have lost the remains of its Upper Carboniferous cover, including any evidence of Triassic valleys, by planation at this time, though it remains a possibility that this planation was mainly sub-aerial, later in the Tertiary. It must be the case that these advancing, and fluctuating, seas together with the river systems which drained into them, planed off benches elsewhere in the region, and the way in which the Downs surface continues NE under the Rhaetic and later rocks at Golden Hill and the Filton plateau encourages the belief that the Downs surface owes its origin at least partly to this time, though it may well have been re-trimmed later (indeed re-Trymed, because the contemporary stream occupies an ancient Triassic excavation).

Whereas the first group of erosional episodes which affected the 'old' landscape were dominantly marine, the second group of episodes, those which were associated with the exhumation of the old landscape in later Tertiary time, were predominantly sub-aerial. We have already seen that the divide between the old and new landscapes also separates two river patterns; the easterly flowing Thames

-based system constituting the remnants of a once high level (200-300 m) and mature river system flowing gently down a dip-based peneplain, being vigorously attacked by a westwards flowing, Severn-based system whose shorter scarp streams were destroying the old high level plateau country and revealing the old landscape beneath.

Capture of the higher level eastern system by the lower level western one was accomplished simultaneously with the beginning of exposure by downcutting of the old landscape beneath, with its particular distribution of upfolds and downfolds, tough rocks and weak. Inevitably, as more of the old landscape was exposed, there would be adaptation of the vigorous downcutting streams when and where they found themselves flowing by chance along downfolds and on weaker rocks, so that alignments in these cases would tend to conform to the lineaments of the old landscape. Thus there are frequent examples where modern streams follow ancient valley lines and, of course, as a corollary, where ancient hills are once again the hills of today. But equally, there are cases where the downcutting streams found themselves by superimposition flowing across the grain of the tougher elements of the old topography and the Bristol Avon in the whole of its lower course is a classic example of this.

THE BRISTOL AVON

From its source to the Severn the Avon, having started as a Cotswold dip stream, has cut for itself a successive series of spectacular gorges and basins, starting with the Limpley Stoke gorge by which it cuts through the Cotswold escarpment at Bath, the flood plain through the low-lying scenery around Keynsham, another gorge through Pennant Sandstone where it cuts across the southern limb of the Kingswood anticline, a further flood plain on the Trias-covered Coal Measures basin on the site of urban Bristol, through its famous gorge across the Trias un-roofed Westbury-on-Trym anticline and so finally to its flood plain across the Severn lowland at its mouth. While other streams parallel to the Avon were by chance let down through the Jurassic cover onto an old landscape whose grain offered no obstacles (the Parrett, Cary, Brue, Axe[4], Blagdon Yeo, Little Avon and Stroud Water, all shown in Figure 5a), the Avon in strong contrast, was superimposed across a variety of transverse elements with only minor adjustment to structure, mostly by its tributaries. There was some minor re-orientation, probably by meander migrations in the clay-filled vales, so there is a short east-west orientation through urban Bristol where the Bristol Frome makes a junction, but this is a minor aberration to a direction which is otherwise consistently to the north-west. This point has led to some controversy, however, and deserves to be looked at in more detail. Between the Hanham and Clifton gorges the valley of the Bristol Avon runs almost due east to west for about four kilometres obliquely across the northwestern edge of the Bristol Coal Measures syncline, here still partially covered by Triassic Sandstone. If followed to the south west, this syncline tightens and shallows between the Westbury-on-Trym and Broadfield Down anticlines and the Triassic valleys, as revealed by the Dolomitic Conglomerate, suggest that this col (the Flax Bourton gap) was a drainage divide between the Bristol and the Nailsea basins in late-Triassic time just as it is today. This ancient structural feature has been re-excavated in recent geological time and the suggestion has been made that it once formed the lower course of the Bristol Avon, the river then being diverted away from

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[4] Except that the Axe cuts through the Mendip axis at Uphill just before it reaches the sea.

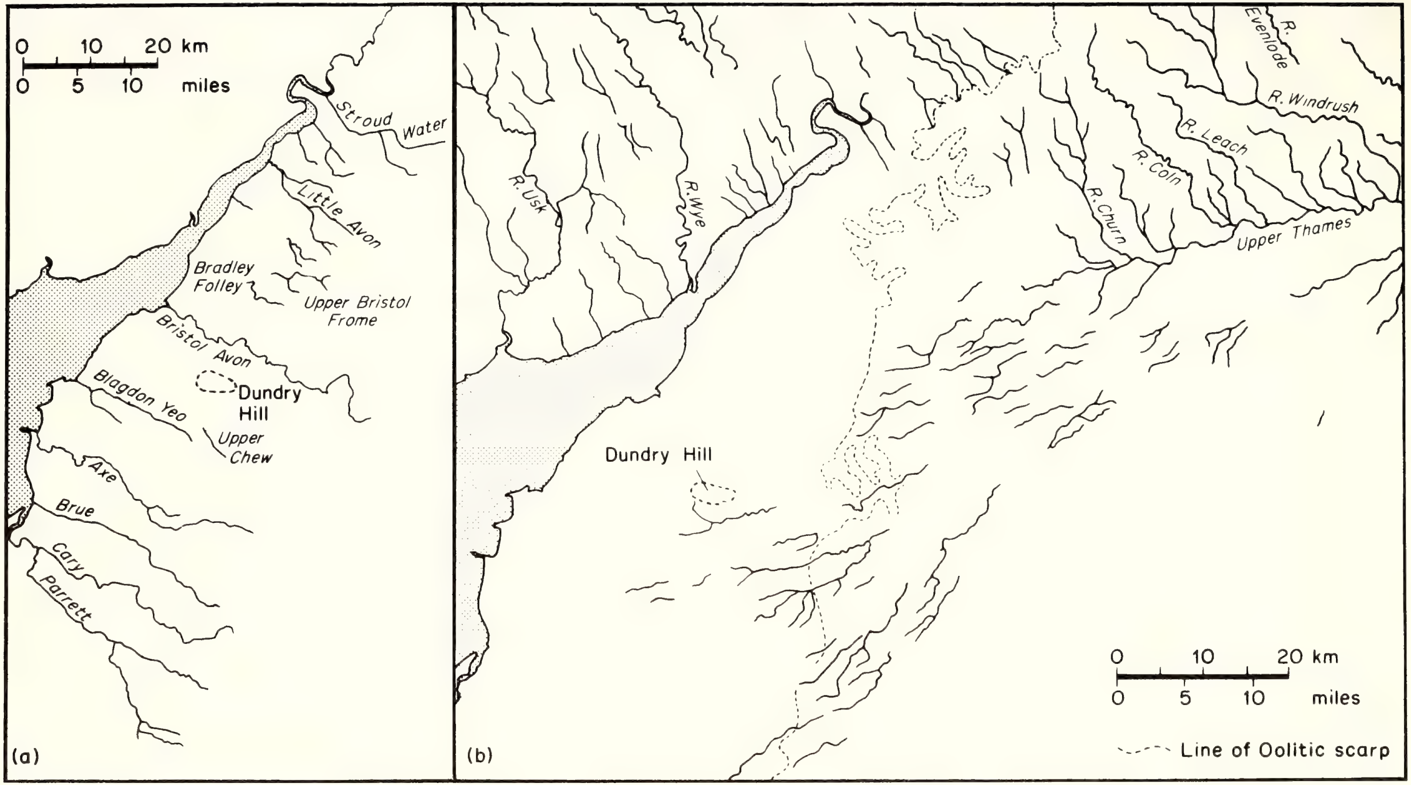
0 10 20 km
0 5 10 miles
Stroud Water
Little Avon
Bradley Folley
Upper Bristol Frome
Bristol Avon
Dundry Hill
Blagdon Yeo
Upper Chew
Axe
Brue
Cary
Parrett
(a)
R. Usk
R. Wye
Dundry Hill
R. Churn
R. Coln
R. Leach
R. Windrush
R. Evenlode
Upper Thames
0 10 20 km
0 5 10 miles
Line of Oolitic scarp
(b)

FIGURE 5 River pattern elements of the Bristol district.
a) North-west to the Severn.
b) East-north-east to the upper Thames.

this course when later Quaternary ice, advancing up the Severn Estuary, ponded back Avon waters during the summer melts into a pro-glacial lake which overflowed north-westwards across the Westbury-on-Trym anticline to create the Avon Gorge.

This possibility was advanced by Hawkins (1972) whose valuable work has identified Quaternary deposits widely over the Bristol region (Gilbertson & Hawkins, 1978), so that there can be no doubt that ice invaded the region on at least one occasion. Nonetheless, there are considerable circumstantial problems surrounding this suggested diversion, the arguments against being as follows. If the Avon had indeed occupied the Flax Bourton gap until at least the mid-Pleistocene and then abandoned it suddenly, there surely would be abundant depositional evidence in the form of terraces, bed deposits, meander cliffs etc. Second, the regional river pattern (Figure 5a) shows that the Severn-bound streams display a strong parallelism in their north-westwards courses such that a WSW course for the lower Avon would be inconsistent with this symmetry. Assuming that ponding back took place by an ice front which had advanced from the west and penetrated the low-lying land bordering the Severn so blocking the mouth of the Avon, the lake level would rise until it could seek an outlet over the first lowest col available. To suggest that this was across the Downs surface at over 100 m, when even today the sharp and non-degraded edges of the gorge do not suggest a pre-existing col, and when there were several lower overflow points available, seems inherently unlikely. Add to this the fact that, if Kenn Moor had been penetrated by an ice tongue at least 100 m thick then so too would the Severn lowlands around Avonmouth, making a sustained overflow in this direction unlikely. Yet further, knowing the way in which recent erosion tends to re-excavate old Triassic valleys, it is interesting that the Avon Gorge cuts obliquely across one such valley (see Figure 1) rather than exploiting it, suggesting superimposition rather than the exploitation of a pre-existing col. Of course, even though no evidence has yet been found (lacustrine deposits or marginal benching), it is entirely possible that ice damming could have resulted in the ponding of waters for limited periods in the Bristol basin, but it is not necessary and indeed highly improbable to invoke such a mechanism to divert the lower Avon. Finally, such an explanation would do nothing to account for the other gorges in the Avon system, especially the deep convolute trench at Blaise Castle through which the tiny River Trym makes its passage across the Carboniferous Limestone rim of the Westbury-on-Trym anticline from its source by Filton airfield to its junction with the Avon at Sea Mills. The cutting down of the region's rivers through the 'new' landscape onto the 'old', a process of superimposition[5], perfectly adequately explains all these features.

Thus explained by superimposition, the Bristol Avon inevitably runs across the grain of a variety of different rocks (Lloyd Morgan, 1885), all with different characteristics, and it is to the environmental variety of the rocks exposed in the Avon Gorge that we now turn.

THE GEOLOGY OF THE AVON GORGE

On its way from Bristol to the sea the gorge cuts through the Westbury-on-Trym anticline, a structural feature trending at 065° which plunges gently to the ENE. The fold is asymmetric with steep dips, sometimes overturned, to the north west and more gentle dips to the south east, a characteristic of all such folds in the region (Figure 6).

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[5] The process of superimposition is explained with diagrams in Bradshaw (1966).

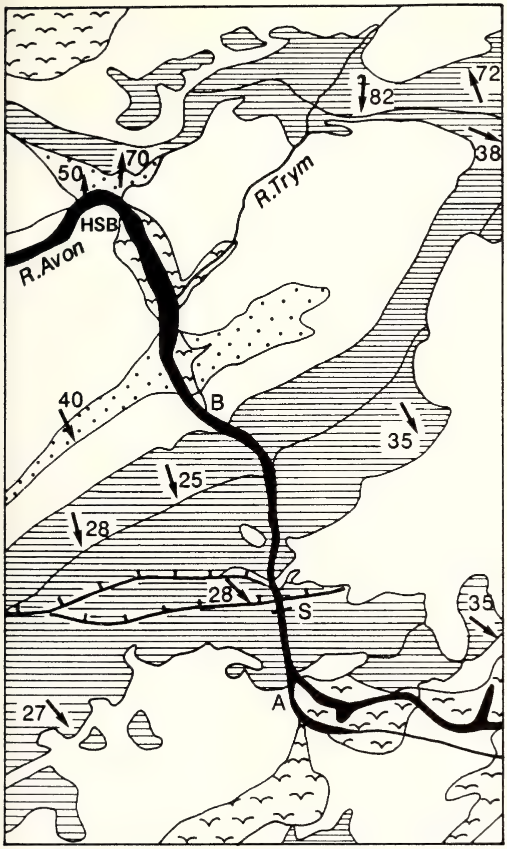


FIGURE 6 Simplified geological map of the Westbury-on-Trym anticline (based on BGS map 1 : 50,000 Bristol).

HSB - Horseshoe Bend.
S - Suspension Bridge.
A-B - Limits of map on Fig. 8.

The rocks involved, ranging from Devonian Old Red Sandstone to Carboniferous, have long been studied so that, even by the early nineteenth century, some 300 individual strata had been identified and described (Bright, 1817; Cumberland, 1821). A detailed study by Vaughan (1905, 1906) brought a major insight and resulted in the subdivision of the Carboniferous rocks into a number of zones, each of which was named after a characteristic fossil (Figure 7).

The 1906 paper by Vaughan in our Proceedings, "to serve as a geological guide to the grand section of Carboniferous Rocks which is exposed in the gorge", was revised by Reynolds in 1935 and provides detailed descriptions of the rocks and fossils to be found on both sides of the river (Figure 9). Some of the photographs in the Reynolds revision were taken before the destruction of the Hotwells to Avonmouth railway, while others show the new Portway road which was built, in part, along the line of this old railway. The distribution of Vaughan's zones is clearly indicated on the plates so that they form even today an invaluable guide to the identification of these strata in the field. These photographs also show that the form of the gorge is not entirely natural, but that it has been modified, sometimes extensively so, by quarrying for building stone and lime, by the digging of cuttings for railways and roads and by the removal of rock because of potential slope failure. Prints and paintings by artists in the eighteenth and ninteenth centuries not only provide valuable evidence of former vegetation used by other

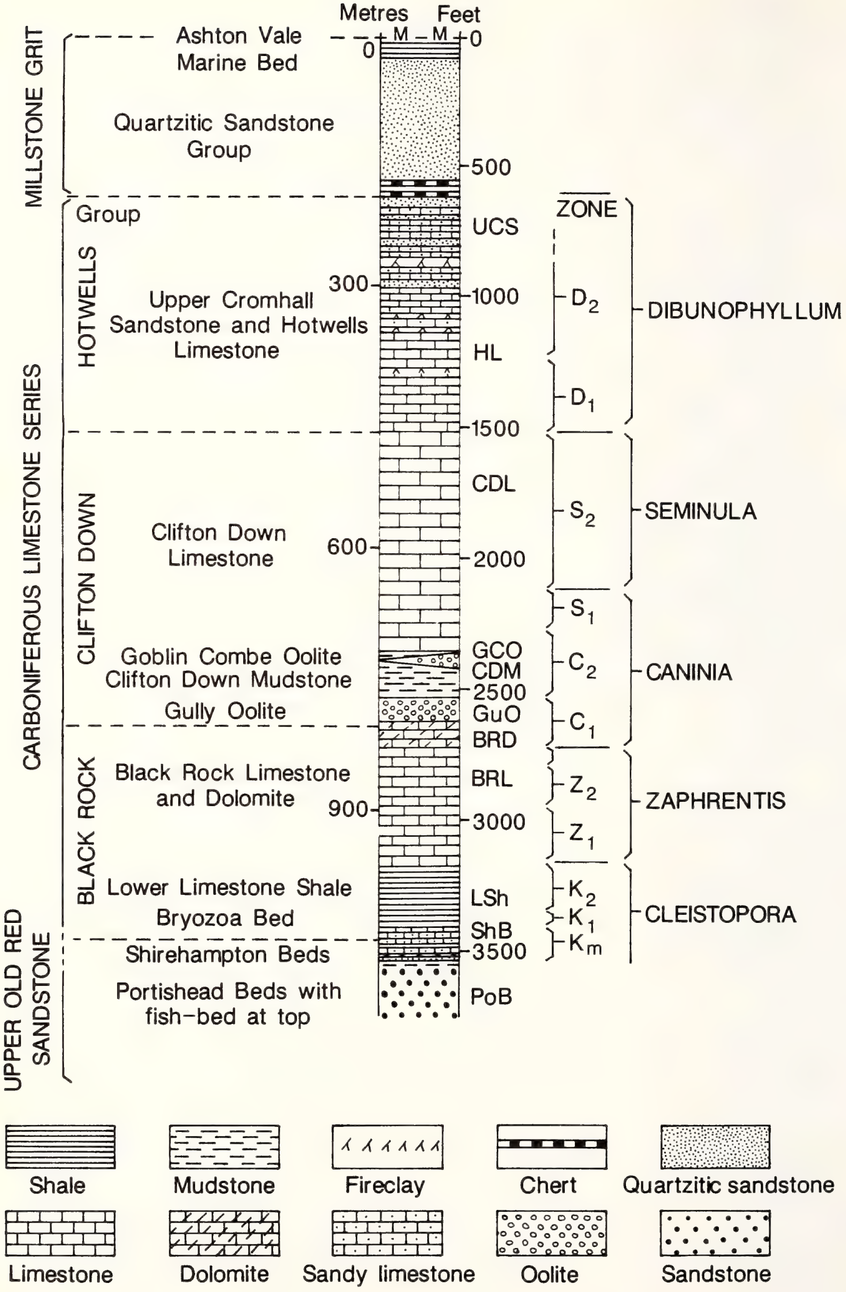

Metres
Feet
MILLSTONE GRIT
Ashton Vale Marine Bed
M – M
0
0
Quartzitic Sandstone Group
500
CARBONIFEROUS LIMESTONE SERIES
HOTWELLS Group
UCS
ZONE
300
1000
Upper Cromhall Sandstone and Hotwells Limestone
HL
D_2
D_1
DIBUNOPHYLLUM
1500
CLIFTON DOWN
CDL
S_2
SEMINULA
Clifton Down Limestone
600
2000
S_1
Goblin Combe Oolite
Clifton Down Mudstone
Gully Oolite
GCO
CDM
2500
GuO
C_2
C_1
CANINIA
BLACK ROCK
BRD
Black Rock Limestone and Dolomite
BRL
900
3000
Z_2
Z_1
ZAPHRENTIS
Lower Limestone Shale
Bryozoa Bed
LSh
ShB
3500
K_2
K_1
K_m
CLEISTOPORA
UPPER OLD RED SANDSTONE
Shirehampton Beds
Portishead Beds with fish-bed at top
PoB
Shale
Mudstone
Fireclay
Chert
Quartzitic sandstone
Limestone
Dolomite
Sandy limestone
Oolite
Sandstone

FIGURE 7 Subdivisions of the Carboniferous Limestone Series based on Vaughan (revised by Reynolds) (1935) and Kellaway & Welch (1955).

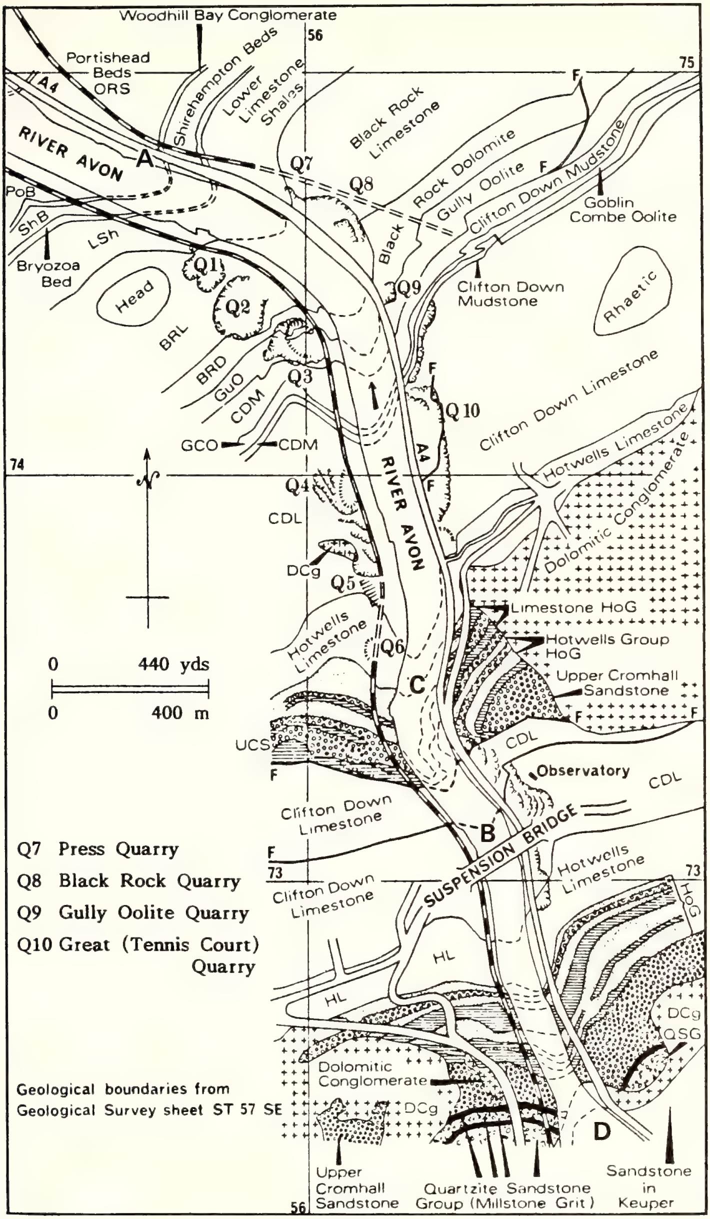

Woodhill Bay Conglomerate
56
Portishead Beds
ORS
Shirehampton Beds
Lower Limestone Shales
75
A4
RIVER AVON
A
Black Rock Limestone
Black Rock Dolomite
Gully Oolite
Clifton Down Mudstone
F
Goblin Combe Oolite
Q7
Q8
PoB
ShB
LSh
Bryozoa Bed
Q1
Q2
Head
BRL
BRD
GuO
CDM
Q3
GCO
CDM
Black
Q9
Clifton Down Mudstone
Rhaetic
Clifton Down Limestone
Q 10
A4
74
Q4
CDL
DCg
Q5
Hotwells Limestone
Dolomitic Conglomerate
Limestone HoG
Hotwells Group HoG
Upper Cromhall Sandstone
Hotwells Limestone
Q6
C
0 440 yds
0 400 m
UCS
F
CDL
Observatory
CDL
Clifton Down Limestone
B
SUSPENSION BRIDGE
73
Clifton Down Limestone
Hotwells Limestone
HoG
HL
HL
Q7 Press Quarry
Q8 Black Rock Quarry
Q9 Gully Oolite Quarry
Q10 Great (Tennis Court) Quarry
Dolomitic Conglomerate
DCg
QSG
DCg
D
Geological boundaries from Geological Survey sheet ST 57 SE
Upper Cromhall Sandstone
Quartzite Sandstone Group (Millstone Grit)
Sandstone in Keuper

FIGURE 8 Geological map of the Avon Gorge (reproduced by permission of the Nature Conservancy from Macfadyen, 1970).

A-B Limits of sketch map and section, Fig. 9.
C-D Limits of section on Fig. 10.
(For explanation of letters see Fig. 7).

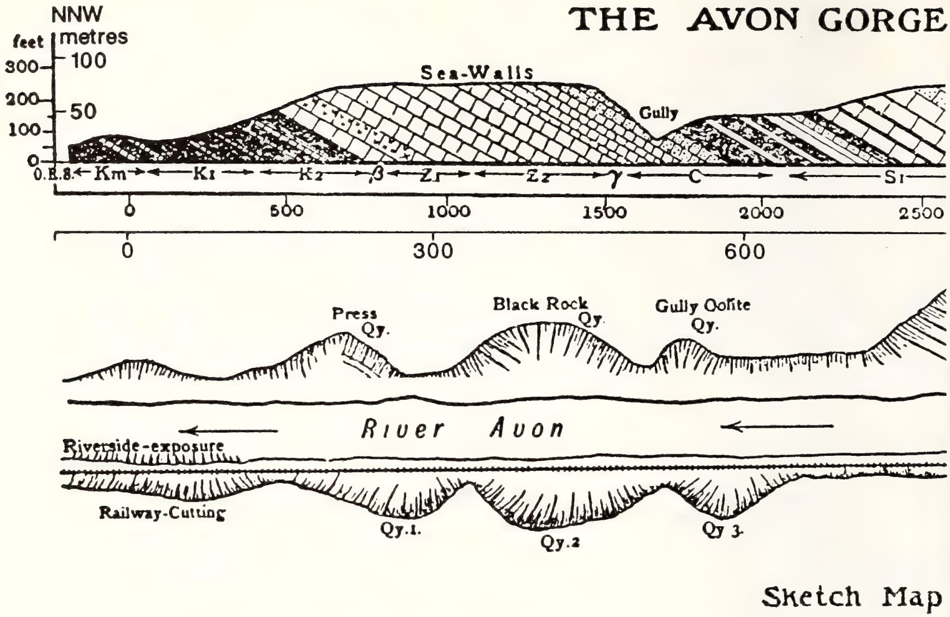


FIGURE 9 Sketch map and section of the Avon Gorge slightly modified

authors in this volume, but give a good impression of the original valley side contours of the gorge (see for example Greenacre, 1973 & 1988; Greenacre & Stoddard, 1986).

More recent work (Kellaway & Welch, 1955) has led to an alternative classification of the Carboniferous Limestone series based on lithology and the new names are given for comparison with those of Vaughan in Figure 7.

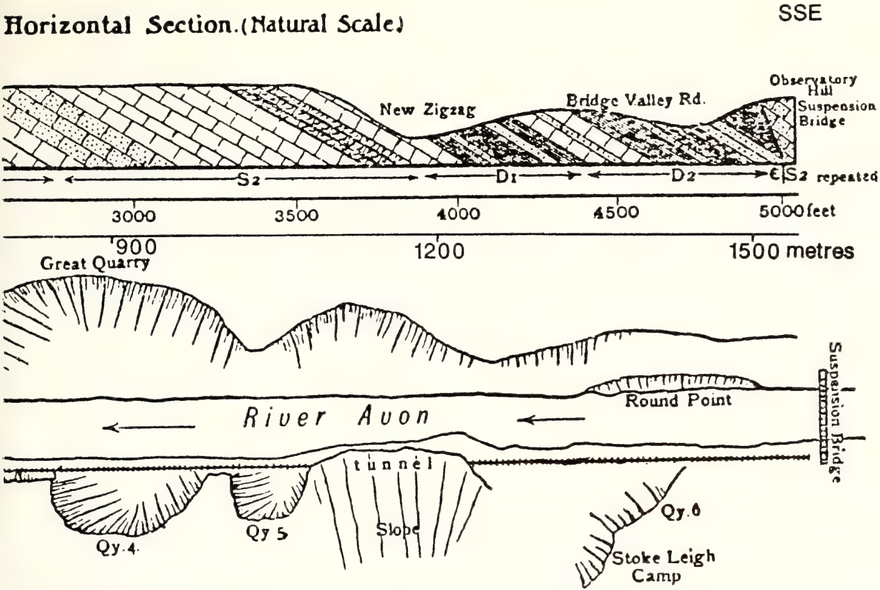
With an anticline, the oldest rocks occur in the centre or the core of the structure so that, to study the sequence of rocks in order of their decreasing age, we must work upstream and down dip from the core, starting at the Horseshoe Bend of the Avon (HSB on Figure 8). The section in the right bank of the Avon here shows the huge amount of erosion that took place during the Permian and Triassic following the creation of the Westbury-on-Trym anticline in late Carboniferous/early Permian time. Horizontal Dolomitic Conglomerate of the later Triassic rests on steep to vertical iron-impregnated beds of the Old Red Sandstone, demonstrating that some 2440 metres (8000 feet) of Coal Measures, Quartzitic Sandstone Group, Carboniferous Limestone and Old Red Sandstone had been removed by the end of the first major cycle referred to earlier.

By concentrating attack on a crestline weakened by tensional stretching over the arch of the anticlinal upfold, Permo-Triassic erosion effectively 'unroofed' this anticline and reversed the relief (so that the flanks of the anticline instead of the crest became the highest ground), in the process veneering the Old Red Sandstone core of the structure with very much younger Triassic deposits.

The Old Red Sandstone, of fluviatile origin and deposited by rivers flowing southwards from an upland region over Wales, consists of conglomerates, sandstones and mudstones with rare occurrences of fossil fish. They are best seen in the shoreline cliffs to the south west of the Marine Lake at Portishead.

The low-lying deltaic flats of the Old Red Sandstone were eventually drowned

Horizontal Section.(Natural Scale)



of Quarries

from Vaughan & Reynolds (1935). (For location of quarries see Fig. 8).

by the rising sea level of early Carboniferous times and the transitional rocks, from the Portishead Beds to the Shirehampton Beds, can be seen by the side of the Portway (see Figure 8 for location). The coastal margin of this lower Carboniferous sea eventually lay to the north of the Forest of Dean and for most of lower Carboniferous times the Bristol area was the site of a shallow shelf sea in which the environments, and thus the sediments produced, changed from time to time. The dominant rock is limestone but of great variability - oolitic, pisolitic, bioclastic, algal - and with an abundant fossil content. Mudstones, sandstones and cherts are important constituents of the series in certain localities. Sea level fluctuated and on occasions the sea retreated so that a terrestrial regime was established and fossil soils (palaeosols) are found at several levels, the best one being above the Gully Oolite (Figure 8).

The simplified section given by Vaughan (1906) (Figure 9) and the map by Macfadyen (1970) (Figure 8) show the main rock groups encountered as we proceed up the gorge towards the Suspension Bridge. As the junction of Bridge Valley Road is approached, the Hotwells Group, which is of massive limestone in its lower part, here begins to develop beds of shale and sandstone (the Upper Cromhall Sandstone) which are the result of floods of terrigenous debris poured into the sea by rivers flowing from the land to the north of the Forest of Dean and pushing the shoreline further to the south.

A diversion up Bridge Valley Road will show outcrops of Dolomitic Conglomerate with boulders up to 1.5 m in diameter resting on rocks of the Hotwells Group. This is part of a channel or wadi which has its head to the north west in Leigh Woods and which obliquely crosses the line of the present day gorge to run beneath Clifton and Redland, where the conglomerate thickens considerably, on its way south eastwards to debouch onto the Triassic lowland on the site of present day Bristol, one of many such wadis as we have already seen (Figure 8).

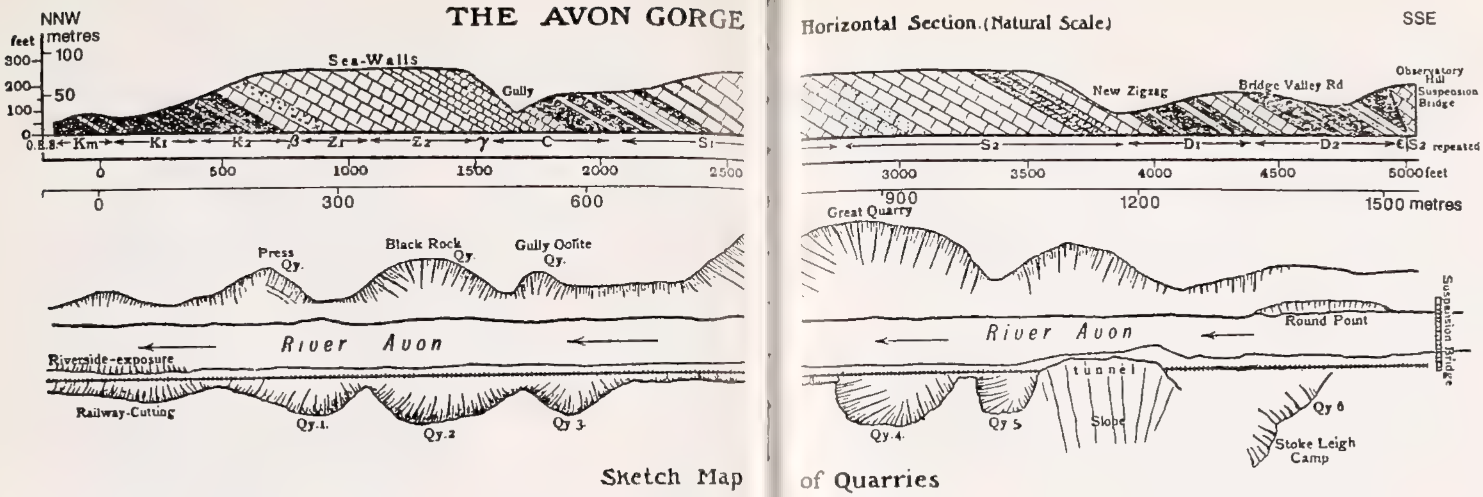

THE AVON GORGE
Horizontal Section.(Natural Scale)
NNW
SSE
feet
metres
300
200
100
0
100
50
Sea-Walls
Gully
New Zigzag
Bridge Valley Rd
Observatory Hill
Suspension Bridge
0.E.8 Km K1 K2 β Z1 Z2 γ C S1
S2 D1 D2 €|S2 repeated
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 feet
0 300 600 900 1200 1500 metres
Press Qy.
Black Rock Qy.
Gully Oolite Qy.
Great Quarry
River Avon
Round Point
Riverside-exposure
Railway-Cutting
tunnel
Slope
Qy.1.
Qy.2
Qy 3
Qy.4.
Qy 5
Qy 6
Stoke Leigh Camp
Suspension Bridge
Sketch Map of Quarries

FIGURE 9 Sketch map and section of the Avon Gorge slightly modified from Vaughan & Reynolds (1935). (For location of quarries see Fig. 8).

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In the cliffs below the Observatory and about 300 m north of the Suspension Bridge the rocks, which have had a fairly even dip of about 30° SE, are here much disturbed, folded and fractured. This is not easy to see today because of mantling vegetation, but the sections drawn by Kellaway (Figure 10) show the situation quite clearly. Detailed examination shows that the simple sequence we have followed so far has been changed and that the rocks of the Clifton Down Group which are first found in the Great Quarry have been pushed over the Hotwells Group by a thrust fault, the Avon Thrust, which has a downthrow to the north of 335 m (1100 feet). A further fault, the St. Vincents Rock Fault, can be seen just below the Suspension Bridge. As a result of these tectonics, immediately upstream of the Bridge the succession from Clifton Down Limestone through the Hotwells Group is repeated. One of the Sandstone units in the Hotwells Group supports the promontory on which Windsor Terrace in Clifton is built.

Around St. Vincents Rocks, exposures of Dolomitic Conglomerate formerly yielded potato stones, concretions of silica which in some cases when broken open revealed perfect quartz crystals growing in the cavities; these are so-called Bristol diamonds (Marshall, 1889; Bradshaw, 1968).

The view of the cliff facing downstream of the Suspension Bridge shows well the bedding planes, fault planes, joint patterns (often reddened) and fissure infills. The last named were open fissures on the steep slopes of the limestone in the Triassic landscape into which debris accumulated and animals fell, although they are much better seen in the Mendips and to the north of Bristol where rich fossil remains have been discovered (Robinson, 1957). The flat tops of the Downs on one side of the river and of Leigh Woods on the other, forming a plateau surface at about 100 m, are also conspicuously on view from the Bridge. Not far away to the north lie the remnants of Rhaetic, Liassic and Jurassic rocks which until recently covered the whole of this area and whose depositional seas must have planed off the Downs' surface across the tilted Carboniferous strata before burying it under some hundreds of metres of Jurassic and Cretaceous sediments.

Upstream of the Bridge the precipitous sides of the gorge fade out and outcrops of rock become fewer, but it has been established that below the Cumberland Basin, alluvium rests on Triassic sandstones and marls which in turn rest on the Quartzitic Sandstone Group, the strata which form the steep hillside which runs northeastwards through Clifton to Kingsdown and southwestwards above Long Ashton village, so delimiting the northwestern side of the Bristol basin. Coal Measure rocks occur below the Trias under much of the Bristol basin and it was these generally less resistant rocks which were worn away from anticlinal crests during the long period of Permo-Triassic erosion, to be preserved only in synclinal basins such as this. These basins became accumulation sites for the waste products caused by the destruction of adjacent uplands until, at the end of the Trias, they too were overtaken by the influx of the Rhaetic and Liassic seas and the massive deposition that followed.

The re-excavation of this old landscape in Tertiary time has already been featured, but the last episode to affect the Gorge in a major way was during the the Last Glaciation (probably re-inforcing similar previous occasions) when sea level was lower by 50-100 m than at present. The Severn Estuary would have been a valley through which the river Severn flowed and, responding to this much lower base level, the Avon cut a deep channel into its bed to a depth of minus 10.65 m (-34.65 feet) OD in the Cumberland Basin, -12 m (-39.3 feet) at Hotwells and -19.8 m (-65 feet) OD at Avonmouth. As the ice retreated, the subsequent rise of sea level led to infilling of this channel with alluvium on top of the Pleistocene gravels occupying the floor of the trench, so bringing the valley floor up to the level of today (Hawkins, 1962).

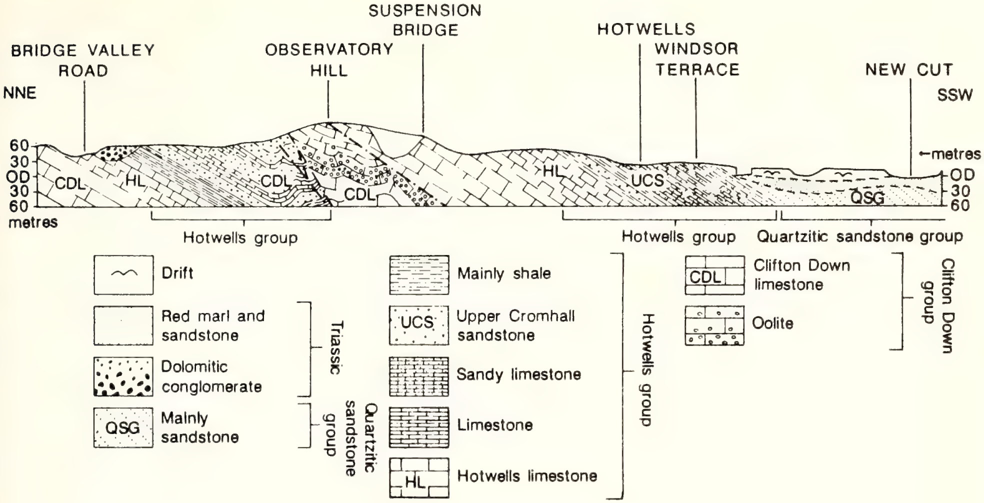
SUSPENSION BRIDGE
HOTWELLS
BRIDGE VALLEY ROAD
OBSERVATORY HILL
WINDSOR TERRACE
NEW CUT
NNE
SSW
60
30
OD
30
60
metres
←metres
CDL
HL
CDL
CDL
HL
UCS
QSG
Hotwells group
Hotwells group
Quartzitic sandstone group
Drift
Red marl and sandstone
Dolomitic conglomerate
Triassic
QSG
Mainly sandstone
Quartzitic sandstone group
Mainly shale
UCS
Upper Cromhall sandstone
Sandy limestone
Limestone
HL
Hotwells limestone
Hotwells group
CDL
Clifton Down limestone
Oolite
Clifton Down group

FIGURE 10 Section through the southern end of the Avon Gorge (modified from Kellaway, 1967).

CONCLUSION

This paper has attempted to describe in simple terms enough of the appearance and the geological history of the Avon Gorge to make it comprehensible to the general reader. It is a matter for satisfaction that much of the important work that has unravelled the complexities of the geology and scenery of the Gorge has been published in these Proceedings during the present century, work that this paper tries to summarise and build on.

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ROCK SLOPE STABILITY IN THE AVON GORGE

by A.B. HAWKINS

(Department of Geology, The University, Bristol BS8 1RJ)

ABSTRACT

The paper draws attention to the geological background of the Avon Gorge and stresses the significance of this when considering the stability of the rock faces. It offers a general overview, highlighting some of the stability problems which have occurred this century in an area of outstanding scenery.

INTRODUCTION

In a region well-known for its many scenic features, the Avon Gorge is probably the most prominent in the Bristol area, descending from the almost flat topography of the Clifton and Durdham Downs and Leigh Woods at about 85 m above OD to the banks of the Avon at about 10 m above OD.

The natural wooded slopes of the Gorge are generally at about 35°. In many places, however, the valuable limestones have been quarried, the proximity to the river providing a convenient means of moving the stone in the days when horse-drawn carts were the only other form of transport. On the Bristol side of the Gorge the quarries were quite large and simply extended as excavations into the valley slopes. On the west side, however, they were more restricted laterally but in several places penetrated further into individual limestone beds, probably because almost all the rock from here was transported via only a few river jetties (see Plate 1).

The Gorge therefore presents a contrast between natural wooded cliffs and steep quarried slopes. Notably on the Leigh Woods side, the smooth surfaces of some exposed bedding planes have provided natural slides for generations of young Bristolians; now sadly they have become prominent sites for grafitti.

The general view of the Gorge, as seen so commandingly from the Clifton Suspension Bridge for instance, has been much influenced by the construction of road and rail transport links. The Bristol to Portishead railway, opened in 1867, runs adjacent to the west tow-path. Still a sporadically active line, it is soon to be re-developed by the Avon Metro. On the eastern side of the river the Portway has replaced the Hotwells to Avonmouth railway line which opened on 6 March 1865 and closed on 1 July 1922 (Maggs, 1975). Plate 2 shows the location of the old Hotwells Station in about 1870.

The construction of the Portway in the 1920s involved not only replacing the railway line with the road but also extensive rock removal as well as the walling of the less competent strata along the lower section of Bridge Valley Road (Reynolds, 1926). In this area the Hotwells to Avonmouth railway line was in tunnel, although few people travelling from the Portway to the Downs along Bridge Valley Road realise that 50 m up from the traffic lights they are in fact passing over a disused railway tunnel.

BACKGROUND GEOLOGY

Many workers have described the spectacular exposures of the Gorge section. No attempt is made to review these here, but it is important to

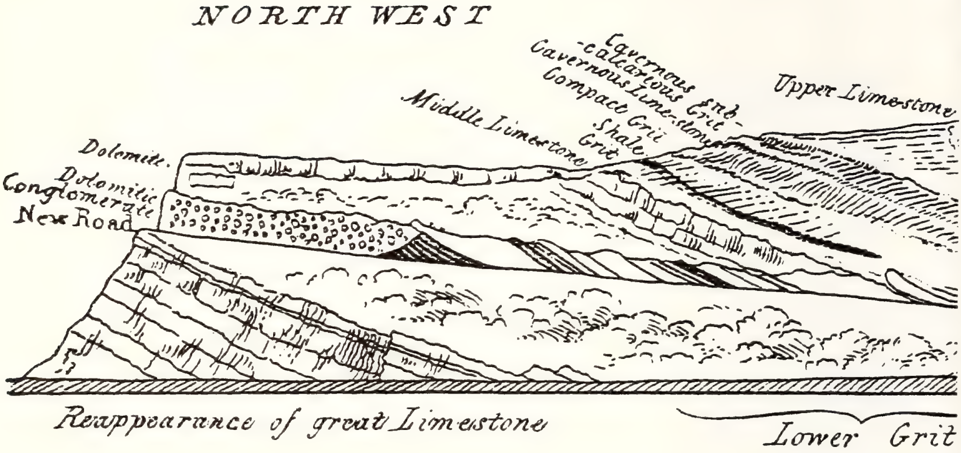
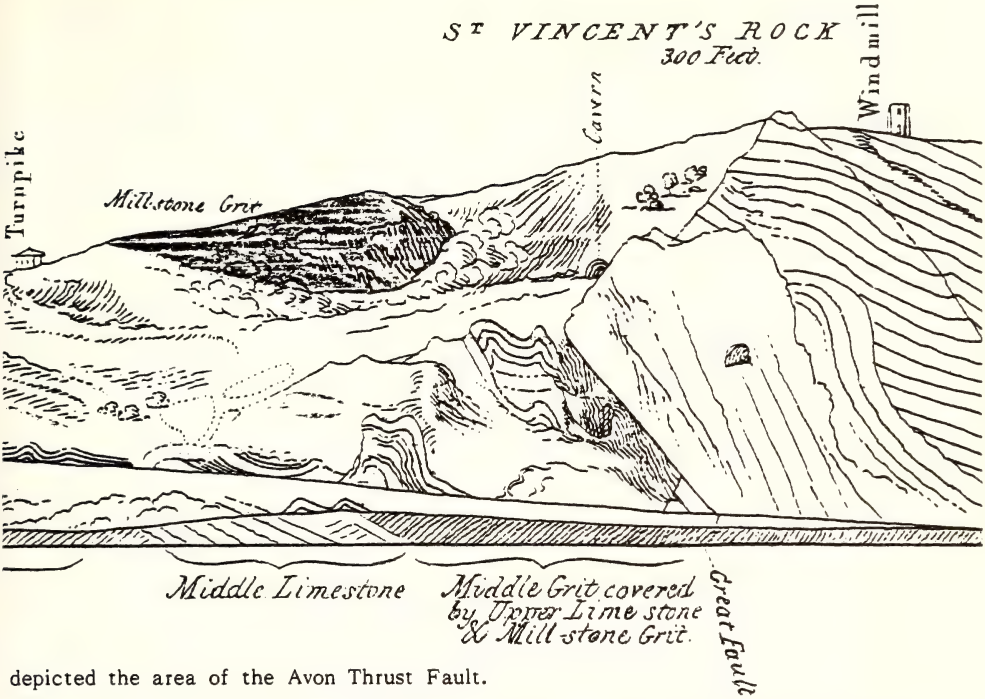


FIGURE 1 Part of the section in Buckland and Conybeare (1824) to show how they

appreciate that even before Geology was established as a course at the University of Bristol, much of the succession in the Gorge, including the Great Fault, had been established. Buckland and Conybeare, in their paper of 1824 included a sketched section highlighting the main features of the geology as understood at that time, part of which is reproduced as Figure 1.

It was Vaughan however, a member of the Bristol Department, who made the first major contribution in his 1905 paper in the Proceedings of the Bristol Naturalists' Society. He examined the rocks in great detail and divided the Carboniferous Limestone Formation into five main zones (becoming famous as the K, Z, C, S and D Zones) and, by using sub-groups, actually identified thirteen strata divisions. His long and highly respected paper also included photographs and overlays which highlight the detail of the geological succession, maling it much easier for others to distinguish his zones and sub-zones in the field. Despite his extensive fieldwork, Vaughan did not appreciate that there was a mid-Avonian unconformity between his C_1 (now referred to as the Gully Oolite) and the C_2 (now the Clifton Down Mudstone). The omission of such details, particularly as there is no clearly visible unconformity in the Gorge (the only evidence being a sudden lithological change) in no way detracts from the tremendous contribution made in his paper.

The next major work was by two Bristol graduates, Kellaway and Welch, who undoubtedly would have heard a great deal about the Vaughan and Vaughan/ Reynolds nomenclature. Whilst re-mapping the geology of the Bristol region at the 1:10 560 scale during the late 1940s, they decided to discard the fossil zonation and instead to use a lithostratigraphic system. this was easier to follow in the field and avoided the necessity to undertake extensive fossil collection at isolated outcrops. The results of their work were set out in two important papers



depicted the area of the Avon Thrust Fault.

at the time of the British Association meeting in Bristol (Kellaway & Welch, 1955a, 1955b). They divided the Carboniferous Limestone into four main divisions:

Hotwells Group -	almost equivalent to Vaughan's	Zone D
Clifton Down Group -	"	Zones C & S
Black Rock Group -	"	Zone Z
Lower Limestone Shale Group -	"	Zone K

It would be inappropriate here to attempt to review or describe the complete geological succession of the Avon Gorge. Discussion is restricted therefore to those lithological and structural aspects relevant to the stability of the rock slopes. It is the structural features, with clear signs of displacement in at least two different directions, that make any appreciation of stability much more difficult than a casual observation of the Gorge would imply.

Within the Carboniferous Limestone there are three horizons where mudstones form a significant part of the sequence: the Lower Limestone Shales, the Clifton Down Mudstones and within the Cromhall Sandstone Series of the Hotwells Group. The numerous minor flexures which occur within the dominantly mudstone sequences, especially in the Lower Limestone Group, are not appreciated from an examination of the main limestone cliff sections. Frequently these mudstones also show signs of bedding plane sliding, with surfaces remarkably smooth and polished when it is considered that the main movements probably took place during the Variscan (Hercynian) Orogeny, some 250 to 300 million years ago.

Now that the outcrop of the Lower Limestone Shales north of the Sea Walls has been obscured by a wall built when that section of the Portway was widened in the early 1970s, the best evidence for a folded structure can be seen in winter, when the leaves have fallen, at the bottom of Bridge Valley Road. Here a drag

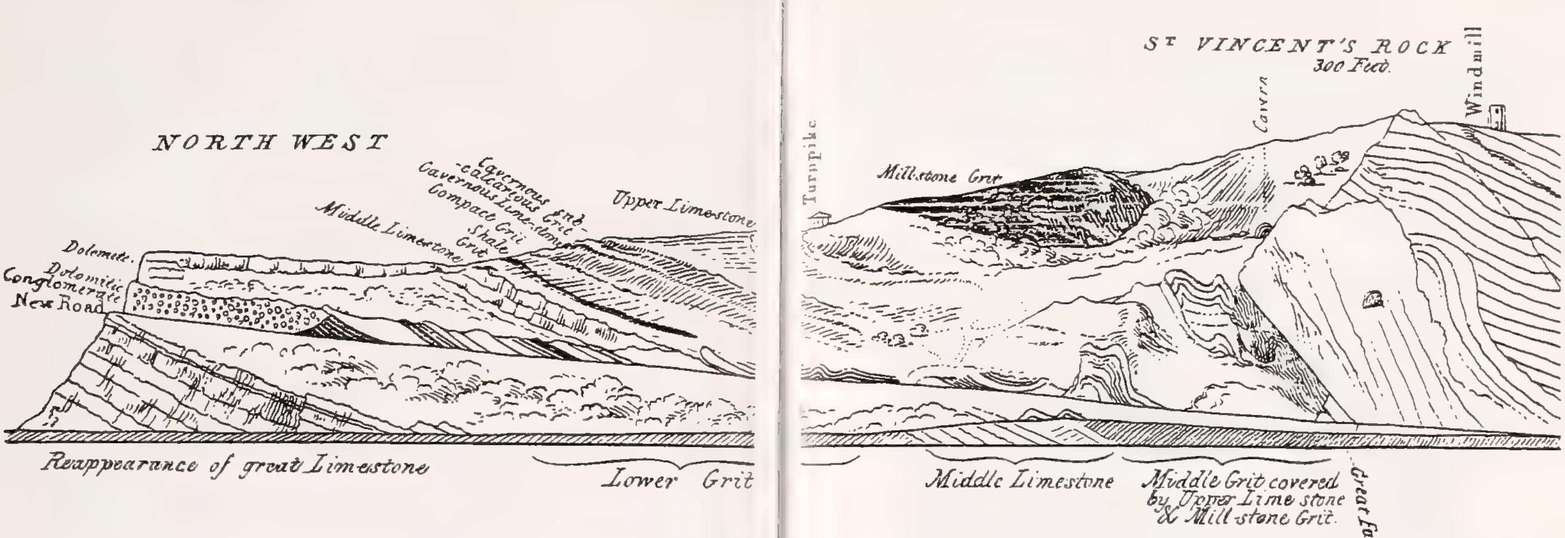


FIGURE 1 Part of the section in Buckland and Conybeare (1824) to show how they depicted the area of the Avon Thrust Fault.

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A number of other thrusts occur elsewhere in the Gorge; the most obvious being on the city side of the Bridge Valley buttress where a sinuous thrust forms much of the rock face before it passes into a bedding plane slide. As a result of stability work undertaken in the 1970s another thrust plane can be seen forming a prominent surface to the north of the Black Rock Quarry, west of the Sea Walls.

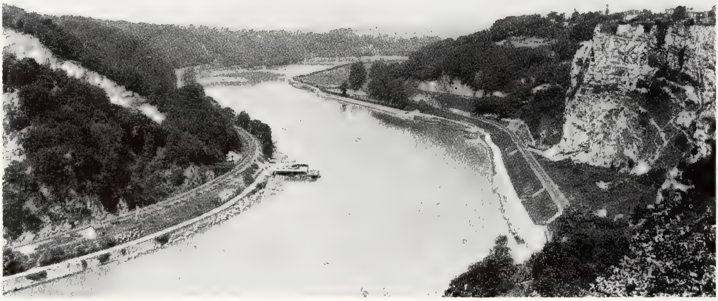

PLATE 1 View of the north end of the Avon Gorge about 1910 showing the railway line and loading limestone from jetty.

The limestones themselves have a bedding thickness varying generally between 0.5 and 3 m, although occasionally thicker beds occur, and in the Gully Oolite the bedding planes are impersistent. The jointing system is usually widely to very widely spaced, 1 to 3 m, but in the more massive limestones the discontinuities are frequently much closer, as can be seen in the Gully Quarry and beneath the Suspension Bridge. These imply that during tectonic movement the thicker beds have been unable to release the imposed stress by bedding plane sliding, hence the brittle nature of the limestones is more noticeable.

The impression obtained in a casual observation of the Gorge is of limestone rocks, dipping south-southeastwards at about 25 to 30°. The occasional sandstone horizons in the Cromhall Series of the Hotwells Group are often not noticed, although they outcrop near the bottom of Bridge Valley Road and can be seen on the right-hand side of Bridge Valley Road itself. Whilst mudstone horizons can be observed at the northern end of the main car park, most of the thicker mudstones in the northern and Bridge Valley areas have now been obscured by the large retaining walls constructed to stabilise them (Reynolds, 1926).

The importance of the prominent joint set is evidenced by the red stained master joints and the clay infilled features observed, for instance, as one approaches the eastern side of the Suspension Bridge. It can be seen that the gorge is aligned approximately parallel to these. It has also been suggested

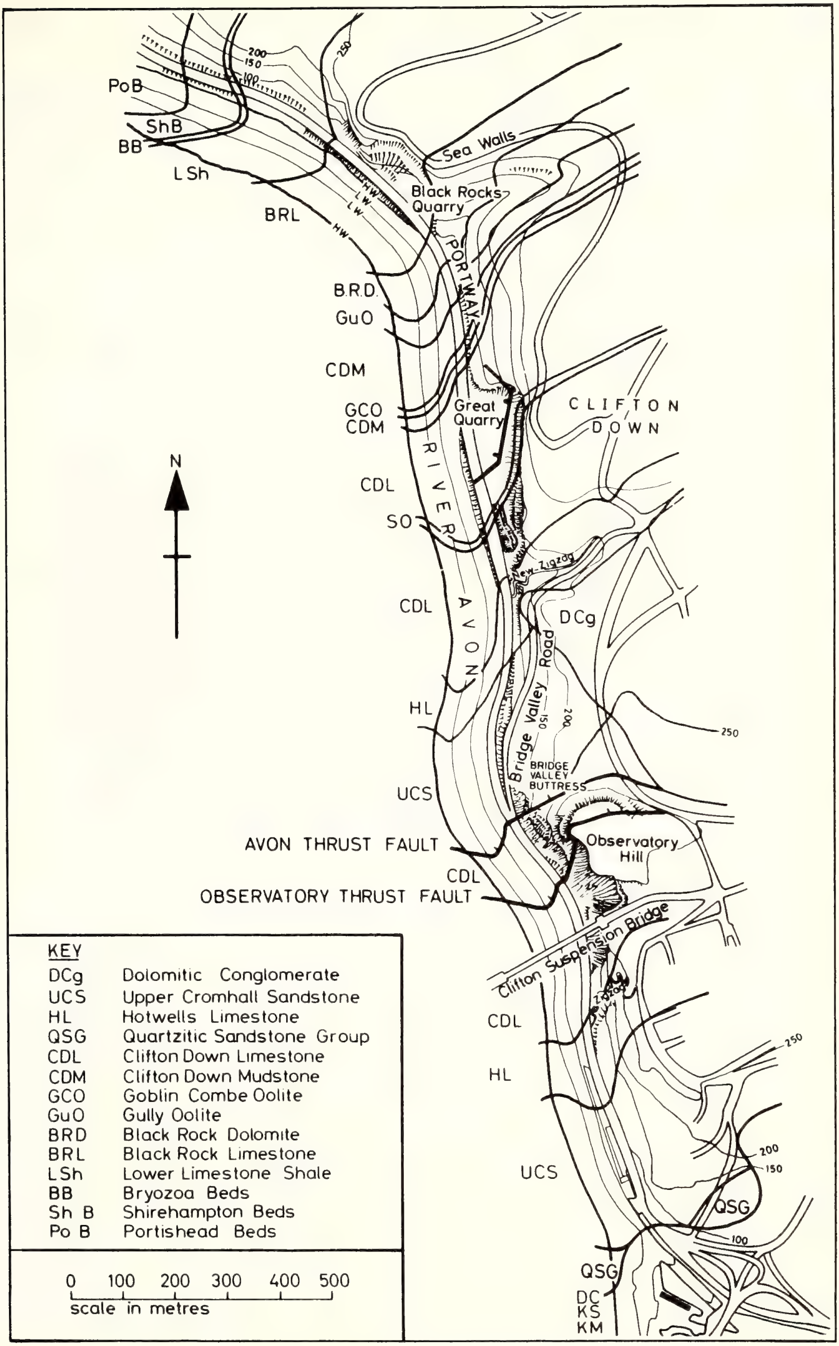
PoB
ShB
BB
LSh
BRL
HW
LW
LW
HW
200
150
100
250
Sea Walls
Black Rocks Quarry
PORTWAY
B.R.D.
GuO
CDM
GCO
CDM
Great Quarry
CLIFTON DOWN
N
CDL
SO
RIVER AVON
New Zigzag
CDL
DCg
Bridge Valley Road
150
200
250
HL
BRIDGE VALLEY BUTTRESS
UCS
AVON THRUST FAULT
Observatory Hill
CDL
OBSERVATORY THRUST FAULT
Clifton Suspension Bridge
Zigzag
CDL
HL
250
200
150
UCS
QSG
100
QSG
DC
KS
KM
KEY
DCg Dolomitic Conglomerate
UCS Upper Cromhall Sandstone
HL Hotwells Limestone
QSG Quartzitic Sandstone Group
CDL Clifton Down Limestone
CDM Clifton Down Mudstone
GCO Goblin Combe Oolite
GuO Gully Oolite
BRD Black Rock Dolomite
BRL Black Rock Limestone
LSh Lower Limestone Shale
BB Bryozoa Beds
Sh B Shirehampton Beds
Po B Portishead Beds
0 100 200 300 400 500
scale in metres

FIGURE 2 Map to show the main strata units which occur in the Gorge section.

(Hawkins & Kellaway, 1989) that these master joints may be the controlling influence on the egress of the thermal water springs.

As a striking scenic feature, the origin of the Avon Gorge has been the subject of many more and less plausible explanations over the years; for an interesting summary see Bradshaw (1965). In 1971 the paper by Hawkins and Kellaway drew attention to new evidence for glaciation of the Bristol area, and strongly supported Harmer's 1907 proposal that the Avon Gorge was an overflow channel eroded when the Flax Bourton Gap was blocked by ice. As a result of both the earlier quarrying and the rock removal required during construction of the road, railway and navigation links through the Gorge, only a small proportion of this original natural valley remains today.

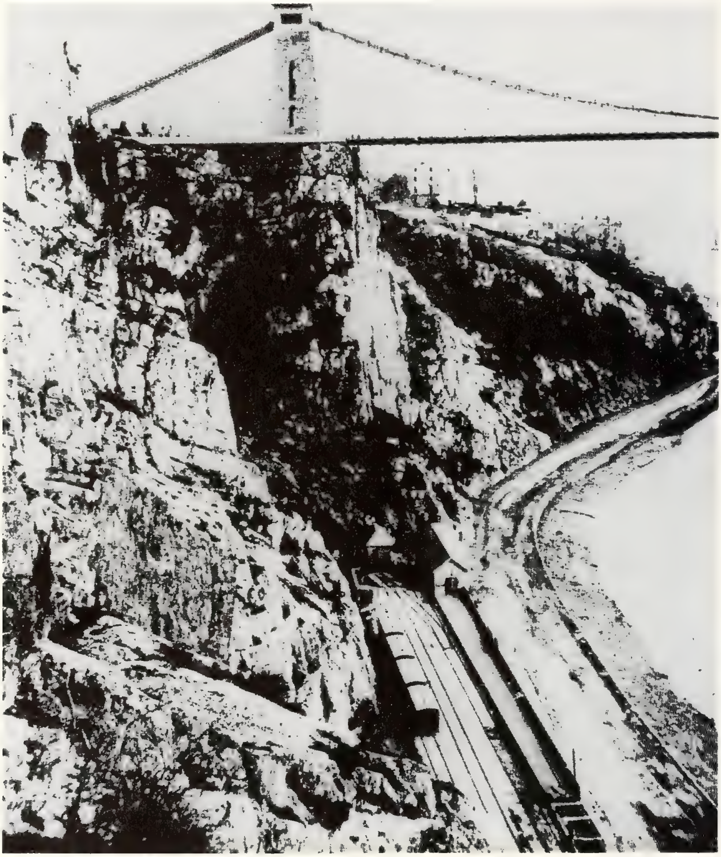

PLATE 2 The Hotwells Railway Station as it was about 1870 (from the Reece Winstone collection).

It is not possible to be confident of the age of the Gorge. It is clearly post-Triassic, as the major Mesozoic valley infilled with Dolomitic Conglomerate is almost at right angles to the present gorge. It is considered that no valley existed until the Anglian Glaciation of the mid-Pleistocene; a deduction based on the age of the glacial deposits in the Failand Ridge to the west and on the level of the col at Flax Bourton, which prior to the erosion of the gorge would have provided a route for the River Avon into the Severn system. In very general terms, therefore, the Avon Gorge was probably eroded quite quickly about half a million years ago (Andrews, Gilbertson & Hawkins, 1984).

PAST INSTABILITIES

Although the major work required in the Gorge in the 1970s was due to rock instability, records show that there had been cause for concern on several previous occasions.

The first records of significant problems are from the time when the Portway was being constructed. Early photographs, such as those in Vaughan (1905), show that there was no retaining wall north of the Sea Walls where the Lower Limestone Shales form the river bank. It was in this area, on the gentle concave bend of the river, that wooden piles were placed to support a major wall structure as part of the Portway construction in the early 1920s. As can be seen in Plate 3 (after Hawkins 1973) the wall failed on 26 September 1924, delaying the opening of the Portway by almost a year and necessitating the redesign of the roadworks in this area to form the pier and bridge system that can still be seen today at the north-western end of the Gorge.

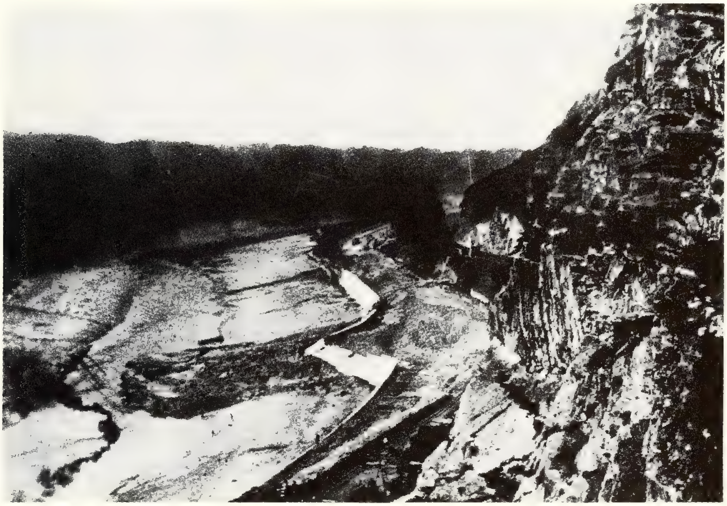

PLATE 3 The 26 September 1924 failure of the retaining wall constructed to support the Portway.

At the end of the last century the Clifton Rocks Railway was constructed at the city end of the Gorge and operated between 1893 and 1937. In 1956 cracks were observed in the area of the tunnel portal and it was noted that the portal structure was moving away from the cliff and the lining of the tunnel was becoming distorted. When the vegetation on the cliff face was cleared the mudstone exposed was found to be much less thick than that proved in the boreholes. Henkel (1961) gives details of the mathematics relevant to a block sliding oblique to the dip direction on an inclined band and comments briefly on the remedial works carried out. The drainage of the mudstone horizon and provision of anchored support to the tunnel portal has effectively controlled the movement.

No evidence has been found to suggest any recent major bedding plane slide has taken place in the Gorge itself. Such a failure did occur however in the interbedded sandstone/mudstone sequence of the Quartzitic Sandstone Group in Hotwells Road, at the site of the filling station. Here movements up to 600 mm occurred in December 1960 when excavations were made into the slope below Southernhay Avenue. Further details are given in Hawkins (1973).

RECENT INSTABILITIES

NORTHERN END

On 16 November 1972 approximately 60 tonnes of rock fell onto the Portway from the Black Rock cliffs immediately below the Sea Walls. As a result of this fall a detailed inspection was made and it became clear that a major rock removal and bolting exercise would be required. In order to undertake this work the Portway was closed for almost two years.

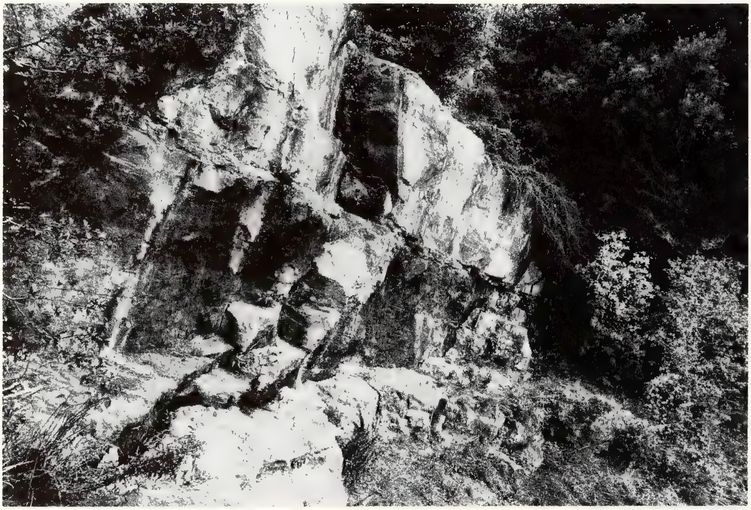

PLATE 4 Crack along the back of the large block, as seen in early 1973.

Examination of the northern face of the Black Rocks Quarry beneath the Sea Walls indicated that the fallen blocks had formed only a very small proportion of a much larger mass, probably in the order of 3,000 tonnes. This was separated from the main rock mass by a large crack which had opened up along an east-west fault plane (Plate 4). Approximately 15 m high and forming the natural termination of the quarry face, the block rested on a thrust plane at about 40°. It was somewhat disturbing, however, to find that the block was overhanging by 5 to 8° to the vertical. In other parts of the cliff face blocks weighing over a tonne were seen to be in a somewhat precarious state almost immediately above the Portway (Plate 5) and quite understandably the City Council, who owned the cliffs and at that time were also the highway authority, decided that a thorough investigation was required.

This work included a careful examination of the discontinuities and planes of weakness or sliding and also the drilling of boreholes to assess the thickness of any clay horizons within the Black Rock Limestone. It was clear from the open nature of some of the bedding surfaces that mudstones were present, and that they had generally weathered back leaving a gap of 25 mm or so at the cliff face.

In order to investigate the major crack which ran along the back of the 3,000 tonne block, in early 1973 a monitoring programme was set up. During February of that year it was found that the crack closed. This implied one of three things: that the block was rotating uphill, that the major cliff face behind was moving downhill, or that the readings were being influenced by climatic conditions. In order to establish the geometry of the movement it was decided to instal a series of extensometers into the face with the fixed ends below the thrust plane. Problems arose, however, in that mathematical calculations implied the block should not have been there! Clearly it was, and had been in a similar position for at least fifty years, as shown in a number of early photographs including Plates 2 and 3.

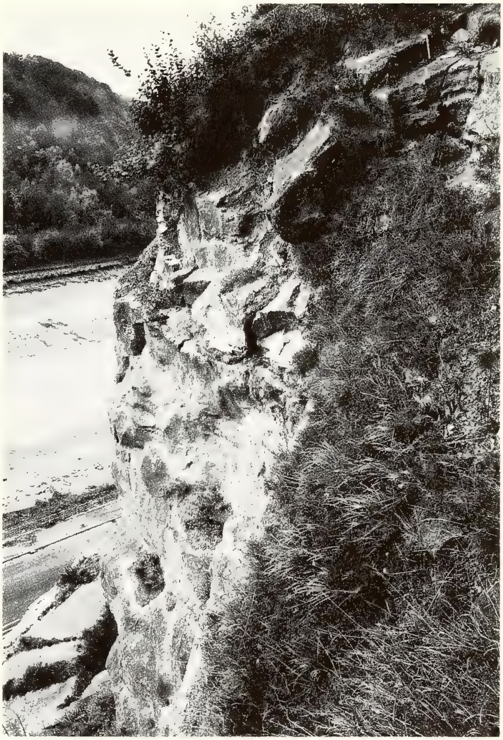

PLATE 5 Unstable blocks precariously resting at 40 m above the Portway, which were removed in early 1973.

As mathematically the block could be shown to be unstable, it was considered to be a potential danger to users of the Portway and to the trunk services, both gas and water, existing below the road surface. Consequently a decision was made by the City Corporation that it should be removed. This was by no means a simple task, however, because from the geometry of the visible discontinuities it was not clear whether, when disturbed, it would topple forward or slide on the thrust plane. In order to remove the block and prevent it falling as a single unit therefore, it was necessary to support it by straps to prevent a toppling failure and at the same time to insert an anchored toe beam to inhibit a sliding failure, Plate 6.

Bristol Corporation let a civil engineering contract for the removal of the large block and the clearly unstable material both upslope of this mass and to the east of the master joint. The material to be removed was not precisely defined, but the contract was worded such that decisions could be made as the work progressed. To avoid the possibility of damage to the road and the services beneath, the contract specification included a clause restricting the amount of material that could be allowed to accumulate on the Portway during the works. In addition, the contractors were required to take out an insurance policy to cover the cost of the reconstruction of the highway should this be necessary as a result of the works.

After the block had been supported by straps and an anchored toe beam, removal began using small blasts. When the block had been totally removed it was clear that only about one third of the surface area had rested as rock on rock, the remainder being on a very dolomitic-rich clay infill up to 100 mm thick. It was concluded that solution had taken place immediately above the thrust plane and the hollow had been subsequently infilled by this clay-rich material.

Upslope of the area of this large 3,000 tonne block, the rock face was scaled so that any loose and overhanging rocks in the immediate vicinity could be removed. At this stage the rock face was re-assessed and a full joint survey and analysis carried out. When all the information was assessed it was clear that as other joints passed through the remaining rock, the work to date had only removed the clearly unstable mass and had not adequately ensured the long-term overall stability of the rocks. A decision was made, therefore, to remove all the rock above the thrust plane west of the master joint. Examination of this area today shows an undulatory thrust plane and clearly it was these undulations which provided sufficient roughness to key the rocks in place. In rock engineering it is always difficult to establish the parameters to be used in a mathematical calculation, but determining the amplitude and wavelength of undulations below the base of a block clearly raises insuperable problems.

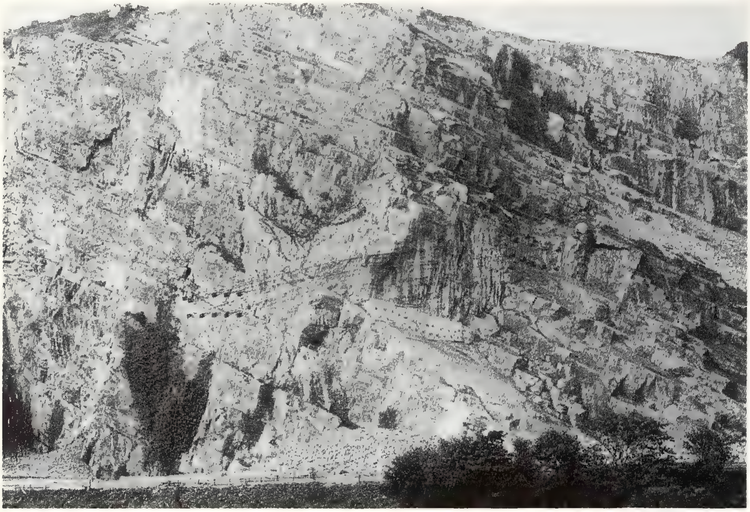

PLATE 6 Supporting straps to prevent the large block toppling and a toe beam to stop the block from sliding whilst being removed, 1974.

East of the master joint a number of overhanging and potentially dangerous rocks were removed and bolts were emplaced to provide support in those areas where removal would have caused problems in overlying strata. The contrast which can be seen in the photographs taken before these works (Plate 7) and since their completion (Plate 8) testifies to the considerable changes to the basic scenery of the Gorge as a result of the stabilisation works in the 1970s.

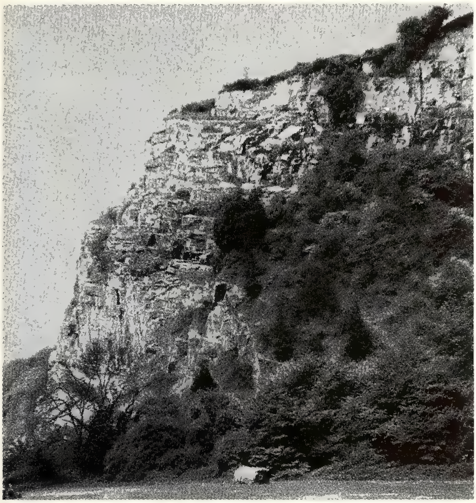

PLATE 7 View of the Black Rock face, May 1973.

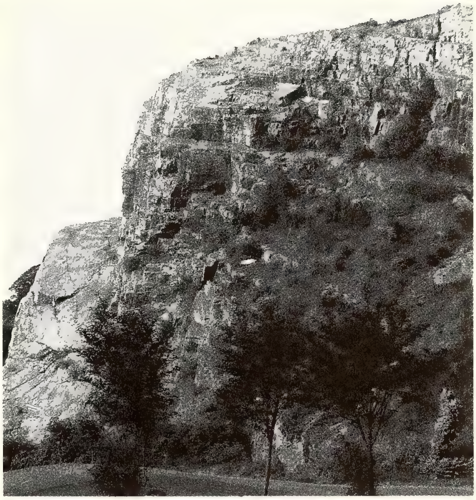

PLATE 8 View of the Black Rock face, September 1988.

SOUTHERN END

As several blocks had fallen from the almost vertical faces of the eastern cliff onto the Portway, in 1977 the owners of much of these slopes requested consultants (MRM Partnership) to report on the general rock stability in that area. An examination of the area under the Suspension Bridge and in the vicinity of the Bridge Valley buttress was made in February 1978. It was found that significant areas contained abundant loose rock and in some places it was difficult to explain how the blocks remained in place.

Following discussions between the owners and Avon County Council (who by this time had taken over as the highway authority) it was decided that it would be necessary to close the Portway again in order to allow remedial works to be carried out to enhance the stability of the rock slopes. Although loose blocks occur in many parts of the Gorge, it clearly would not be practical or aesthetically desirable to treat all the slopes and/or completely restrict rock climbing, but the protection of the users of the highway was of paramount importance.

Inspecting these faces was in itself a difficult task. One method considered was to allow personnel to be lowered down the face using a crane located on the footpath around the pillar of the Suspension Bridge. When holes were dug to emplace concrete supports for the crane outriggers however it was realised that Brunel's design of the northern parapet around the tower included an arched/tunnel section, in part over 3 m in height. This arched section, where solution had eroded a hollow above a major master joint behind the main cliff face, clearly had been incorporated by Brunel to act as a support to the path without imposing any significant lateral pressures on the retaining wall constructed in this area. An alternative method was the use of a very large crane with sufficient reach that even when located on the Portway it could provide access to the whole cliff face. In the event, the superior reach of the crane meant that all of the Suspension Bridge and Bridge Valley faces could be inspected by personnel suspended in a cradle.

During the examination of the near-vertical faces a number of loose blocks were dislodged, many of which fell onto the highway. Close inspection of the rock face also indicated a large number of closely spaced vertical discontinuities. Whilst at the face these appeared open, the cracks were clearly not continuous or the blocks would have fallen. Thus although these incipient discontinuities give the face the appearance of being extremely unstable (Plate 9) frequently when the blocks are prised they do not break away easily. The origin of these open discontinuities and whether or not they are related to stress release is not discussed here.

In addition to these abundant and what would appear to be random discontinuities, a series of parallel, sub-vertical master joints passes at a low oblique angle into the Suspension Bridge face. Examples of such open discontinuities can be seen along the road between the Downs and the eastern pier of the Suspension Bridge. A large crack can also be seen from the Portway in the north-facing slope in the winter. It is likely that the existence of this crack, its subsequent solution to about 500 mm in width and the hollow at the surface (Plate 8) are the reasons why Brunel positioned the eastern pier so close to the sub-vertical gorge face. In the rock face under the bridge two of the master joints are over 300 mm wide for a depth of more than a metre, and are now partially infilled with soil.

After examining the cliff face beneath the Suspension Bridge, the consultants and Avon County Council decided that considerable remedial/precautionary measures were essential. This work would involve either a full mesh cover over the face with anchors to support the larger blocks adjacent to the wide discontinuities, or the construction of a gallery to protect the road, similar to the avalanche rock canopies in other countries. The gallery option was chosen because, although it is more obvious when viewed from a close distance, for the many visitors travelling through the Gorge it does not have as great an aesthetic impact as face meshing as they look up at the famous Suspension Bridge.

During the construction of the Portway, a projecting spur of land had been removed at the bottom of Bridge Valley Road to form what is now popularly referred to as the Bridge Valley Buttress. Unfortunately the rock removal took place using bulk blasting and as a consequence the rock is very broken over parts of the face, in some cases the position of the blast explosions still being clearly visible.

The Bridge Valley Buttress is located between the two main thrust faults in the Gorge. In addition to these two obvious movement planes, fault displacement has caused extensive slickensiding/crystal growth slickensides on steep (40-80°) planes approximately parallel to the bedding dip direction. The location of this thrust ramp feature at the top of the Bridge Valley Buttress creates an apparently smooth surface. At first sight this appears to be a good stable rock but when examined more carefully it is often found to have extensive poorly cemented calcite vein infill. In 1978 a tape could be pushed three metres into the voids along one of these planes.

This calcite veining occupies cracks often of up to fifty and sometimes several hundred millimetres in width. Not only is the infilling intrinsically weaker than the limestone rock mass, but the calcite veining weathers on the crystal cleavages such that it readily falls away. The problem this creates can only be appreciated on close inspection and it is frequently difficult to decide whether it should be removed, or whether the "good" clean face will actually remain stable. In a number of places it has been possible to push a tape over half a metre into the openings behind a calcite "veneer".

Another major cause of face instability is the vegetation. Although there

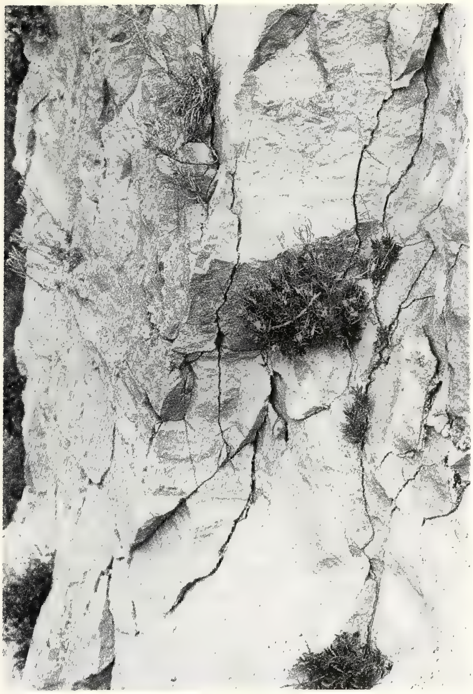

PLATE 9 Incipient closely spaced discontinuities on face beneath the Suspension Bridge.

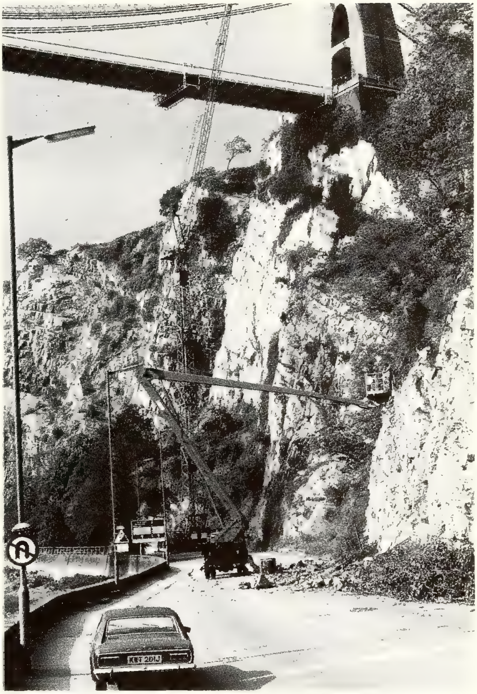

PLATE 10 Work being undertaken in the Gorge, 1979, using two types of crane for access to the face. Note ivy in the oblique master joints at the top of Suspension Bridge face.

may be limited vegetation in the rock areas adjacent to the highway, where trees do occur their roots have a considerable effect. In strata where a joint system has existed for millions of years and where the joints have been partially infilled with either Triassic deposits or wind-blown soil, roots are particularly important. Whilst some have initially simply grown "out of shape" to fit the void, in other places continued growth has clearly widened the cracks. The stability of the gorge face would be enhanced by removal of all such vegetation and the chemical killing of its roots.

Since the completion of a major rock stabilisation programme in 1979, a rock fall occurred at the bottom of Bridge Valley Road, away from the highway and hence not stabilised. Here the medium to thick sandstones of the Hotwells Group have widely spaced joints and are interbedded with mudstones and carbonaceous mudstones. As rocks from this fall reached the metal fencing adjacent to Bridge Valley Road, anchors were installed to support the face. In addition, as a precautionary measure, the disused railway was cleared to act as a catch pit should any further falls occur.

Avon County Council have continued to adopt a very positive policy in those areas where blocks falling from the slopes could reach the highway. Inspections have been carried out at intervals throughout the 1980s and any necessary minor remedial work undertaken.

CONCLUSION

This paper is not intended as a complete scientific review of the stability problems in the Avon Gorge but describes some in more general terms. They are partly related to man's activities in quarrying stone and removing rock for the construction of transport links, but also to the particular geological structure of the gorge itself and its vegetation. Hopefully the paper will stimulate readers to look at the Gorge with a fresh insight on its problems and hence provide them with an increased interest in this area of outstanding scenery.

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As a result of the author's long-standing interest in the Gorge he became involved with the stability problems described in this paper. He acknowledges with gratitude these opportunities and his discussions with the staff of Avon County Council, Bristol City Corporation and the MRM Partnership. He thanks Jean Bees for drawing Fig. 2 and Marian Trott for help in preparing the text.

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Proceedings of the Bristol Naturalists' Society (1987), **47**: 79-84

BIRDS OF THE BRISTOL DOWNS, 1900-1988

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In recent years detailed studies of the status of many common species have been made, but it is rare to have detailed documentation of the common birds of an area over a long period of time. The Downs, however, have been well watched throughout this century and two pamphlets have been published about their birds, by H.C. Playne in 1906 and Averil Morley in 1934. I have combined these with my own notes of transect and breeding studies from 1966-1975 to demonstrate the nature of the changes which the past ninety years have brought to the bird-life of the Downs. I have also used records from "The Birds of the Bristol District, 1899", in the BNS Proceedings, which includes records from H.C. Playne, and the diaries of A.C. Leach who lived near the Downs from 1925 to 1956, and kept notes of the rarities he saw.

In the course of the last ninety years the Downs have undergone extensive changes. Up to 1930 the Downs formed the north-west limit of urban Bristol, beyond which lay open country with farms and villages. The opening of the Portway in 1931, linking Bristol to Avonmouth along the river, and the huge building boom for both private and council estates that began in 1932 saw the Downs become a large urban common, surrounded by increasingly dense urbanisation. It is hard for us now to imagine the dramatic nature of the Portway when opened, for it was the most expensive stretch of road in the country at the time, involving a massive cutting at Shirehampton, extensive embankments and a cantilever over the river at Sea Walls. This urban pressure led to a sharp change in the plant cover of the Downs, which Averil Morley commented on in 1934*. From about 1930 the covering of bracken and gorse was progressively removed, and gang-mown grass took its place. This undoubtedly led to a decline in the numbers of common birds nesting on the Downs, though it seems to have had little effect on the species. More recently the appearance of the Downs has been further altered by Dutch elm disease which has killed almost all the elms which had been planted about 1870. A further slow change has been the collapse from age of hawthorn which are at least 200 years old, and may well be older. They form a beautiful and exceptional feature of the Downs. There is also evidence of the spread of scrub from the edge of the cliff over the plateau surface. The labour force employed by the Downs Ranger seems to be insufficient to prevent this and hence, in some ways, the habitat for birds has improved.

It is hard to tell how far recreational use of the Downs has increased over the years. Car-parking on the grass during a series of summer bank holidays is a retrograde step, though one which as yet has not actually done visible damage, while the heavy use of the cliffs by climbers has made them less attractive to cliff-nesting species. But large shows, visits by circuses and the extensive playing of soccer probably show little change in the last fifty years, and the absence of car parks acts as a limit on the total number of humans using the Downs at peak times. The area most used by breeding species, the steeply sloping wooded slopes covered in trees and scrub, are under least pressure from human use because of their steepness and, in places, the thickness of the scrub.

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* See also the paper by S.D. Micklewright & L.C. Frost in this issue (pp. 21-26) dealing with land-use changes on the Bristol Downs.

In the last ninety years some 86 species have been recorded using the Downs and they are listed in Table 1. Of these, 21 species have been recorded on only a very few occasions, or as migrants heard or seen flying overhead. Of the other 65 species, 33 have not altered their status and comprise 11 that have always been occasional visitors, 16 breeding residents, four regular summer visitors and two regular winter visitors. Another 17 species have declined either in total numbers, or have been lost as breeding species while, at the same time, 10 species have increased in numbers and have usually become breeding species. Finally, five species have appeared to breed regularly for a few years before disappearing again. Playne lists 27 breeding species in 1906, though he omits two or three which probably were present, and Morley lists 28 breeding species in 1934. 34 breeding species were recorded between 1967 and 1975, though there were probably only 28 in 1987. Hence the pattern is one of change, with losses of species counterbalanced by gains. It is not possible from the records to make any assessments about total numbers, but it is known that these fluctuate substantially nationally and it is a fair assumption that for common species the numbers using the Downs have varied in the same way.

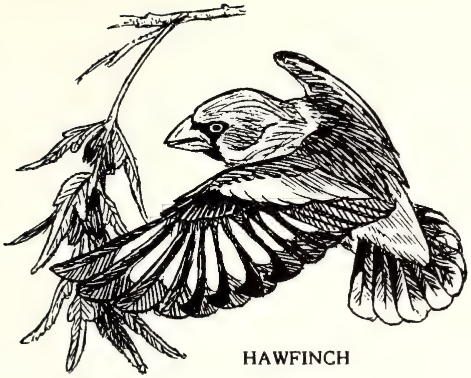
Examining the losses in breeding species first, there is a group which Morley notes had already declined by the early 1930s. According to Playne, the Skylark and the Wheatear once nested on the Downs, though even by the time he wrote the Skylark had become an occasional winter visitor as it has been ever since. The Wheatear was an occasional passage migrant well into the 1930s, but it has very rarely been recorded in more recent times. The Cuckoo and the Nightingale both nested in Playne's time and the Cuckoo was still heard in spring by Morley, though she doubted that it bred. The Nightingale had disappeared by the early 1930s and the Yellowhammer, still breeding in 1906, had become an occasional autumn visitor by 1934. Playne mentions the Redpoll as a nesting species. It was not recorded by Morley and is now only an occasional winter visitor. The Tree Pipit is recorded as a summer visitor by Playne but not recorded since. The 1899 list records the Red-backed Shrike as breeding on the Downs although it is not mentioned in 1906. All these changes are properly regarded as a consequence of growing urbanisation, since all the species are those that dislike disturbance, though several have declined nationally as well over these years.

KESTREL

MAGPIE

SPARROWHAWK

Miss Morley mentions two species in decline in her own day, the Hawfinch and the Linnet. The latter she says was, before the clearance of the early 1930s, one of the commonest nesting species. It lingered on as a breeding bird into the



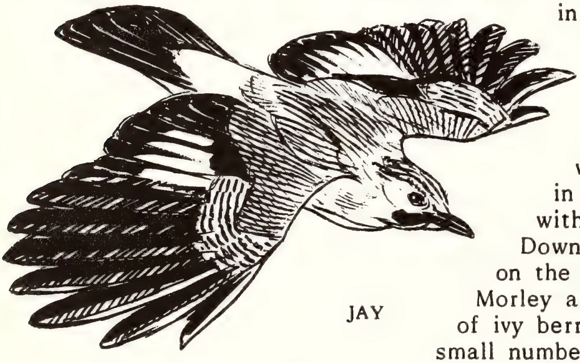
HAWFINCH

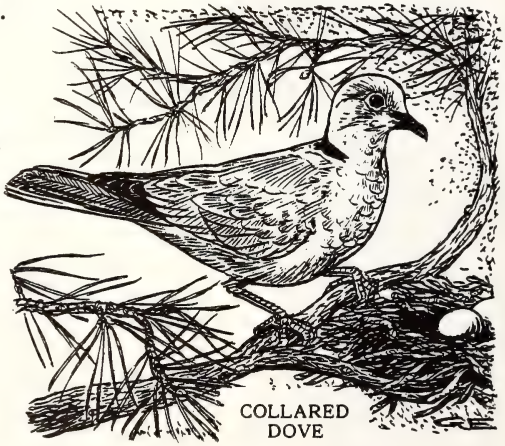
mid-seventies, but is no longer present. The Hawfinch she suggests was common on migration, as many as 40 being seen together in spring, but it had been reduced to a single breeding pair by 1934. It seems to have remained at that population level to the mid-seventies but there have been very few recent records.

Since Miss Morley's day the changes in bird species and numbers have resulted in part from habitat change and in part from wider population decline. The destruction of the elm trees almost ended the Tawny Owl as a breeding species and also saw the end of the Clifton Green rookery, which had begun in 1939. There had also been a rookery at the Water Tower, which Morley mentions, though its fate is unknown. Rooks still use the Downs as a feeding ground in late summer, but the nearest rookery is now at Ashton Court. The Jackdaw has also declined in numbers but only since the 1970s and probably as a result of the pressure of climbers on the cliffs. Miss Morley mentions hundreds nesting and in the early seventies flocks of a hundred or more birds could still be seen, although totals are certainly lower today. Four migrant species have also altered their status. The first two species have suffered a national decline in the numbers visiting in summer and an increase in annual variability, so that the Spotted Flycatcher population of the Downs has fallen in sympathy and this species can no longer be regarded as a regular breeder. The Whitethroat population fell sharply in 1969 and it has not bred on the Downs since, though it was regular until then. The Lesser Whitethroat was an occasional breeder throughout the period up to 1975, but has not been recorded since, and the status of the Garden Warbler is uncertain. Playne does not mention it, but Morley states that it out-numbered Blackcap by nine nests to two on the Gully slopes. In recent times it has been recorded on migration only.

Five other species should be mentioned here. In some senses they must be regarded as losses, but the records suggest that they were temporary breeders at best, presumably finding a suitable site at a time when numbers were high nationally. The most dramatic of these is the Peregrine, which nested from 1927 to 1934. It is not clear from the records whether the eyrie was more ancient than 1927, though it is not mentioned in 1899 or 1906. Two different sites were used between 1927 and 1934 though their exact location is not clear. Morley states that people had attempted to reach the nest using ropes, but had failed to do so. Should the species attempt to recolonise the Gorge it would be unlikely to be successful without protection from climbers. The Peregrines were replaced in 1936 by a pair of Ravens, which continued until 1940, regularly rearing young. Between 1946 and 1955, Leach recorded Cirl Bunting every year. He clearly regarded this as a novelty and the species is not mentioned by Morley, though Playne implies that it was present in the neighbourhood in 1906. This species has declined nationally in the last twenty years. The Redstart was mentioned by Playne as fairly common, but the only site he mentions was Nightingale Valley. Morley does not mention it and Leach has only one record of a juvenile in July 1955. There were records of breeding birds in the early sixties, up to 1966, since when it has been seen once on migration. The Wood Warbler has nested regularly in Leigh Woods until the last two years and Morley records that a pair had recently begun to nest on the Downs. By the sixties it was heard only occasionally on migration.

Some ten species have increased, mostly by changing from being occasional visitors to being regular breeders. Perhaps the most remarkable is the Magpie, a rare visitor in the early 1930s but now a regular breeding species with perhaps four pairs on the Downs, and birds regularly present throughout the year. In the early years it was a persecuted species, but greater tolerance has led to a spectacular increase in numbers in the last twenty years. The Jay too, a shy winter visitor for Miss Morley, is now less shy and breeds in the cliff-edge woodlands, appearing in surburban gardens in winter. Perhaps it is on the way to becoming the regular suburban species that its cousin the Blue Jay is in America. A third member of the crow family, the Carrion Crow, which was represented by a single pair in 1934, is now much commoner with at least four pairs around the Downs, joined by yet others which feed on the Downs. The Wood Pigeon, for Morley also a shy winter visitor in search of ivy berries, is now a regular breeder in small numbers and is often seen in Clifton gardens. The Collared Dove first appeared in Bristol in 1961 when the Zoo became an early feeding centre, with pairs breeding on the Downs nearby. Its numbers have now stabilised. Both Green and Great Spotted Woodpecker were recorded by Playne, though he commented that the latter could be seen in Leigh Woods. By the 1930s both were occasional non-breeding visitors, the Green Woodpecker being more common. By the late 1960s both were breeding species, a couple of pairs in each case, and are still seen throughout the year. Neither Kestrel nor Sparrowhawk were mentioned by Playne, but were recorded as rare visitors by the early thirties although it was not until the early 1960s that they were recorded as breeding. Kestrels nested on one side or other of the Gorge in successive years in the late seventies and Sparrowhawk nested in a tree in the Glen. Both are still seen regularly, though the Kestrel less frequently in the last year or two. The tenth species, the Goldfinch, has a less certain status. It was not mentioned by Playne and in the 1899 list it is regarded as a declining species in the Bristol area. It was a rare visitor for Morley. By the late 1960s it was present at all times of the year and regarded as a breeding


JAY


COLLARED DOVE

species, but I have no recent records.

The causes of increasing numbers seem to lie more in change in habit and also in national population levels than in any change in habitat, though both the Wood Pigeon and the two Woodpeckers may have responded to the ageing of the woodland structure of the cliff slopes. A fall in persecution of the hawks and the Magpie may also be responsible in part. This is in contrast with losses, which seem to be due to habitat change as much as to a national decline in numbers.

GREAT SPOTTED WOODPECKER

CONCLUSION

The conclusion of this study is that over long periods of time change is continuous and subtle, with a balance between gains and losses, and at least four factors at work. These factors can be identified as the changing local habitat; for migrants changes in habitat elsewhere; changes in national population levels and finally, change in a species' own adaptation to its surroundings. All too often change is perceived solely as loss, and related to habitat change which is also called habitat destruction. The Downs have indeed changed greatly in ninety years but the changes in the bird species using them relate more to wider factors than to local ones. My final thought is how important detailed studies of the ordinary are. If only Leach had recorded in his notebooks all he saw and not just the rarities, or if only I had Miss Morley's notebooks and her records of the numbers of pairs she found, how much more rewarding a comparison this would have been.

TABLE 1 A LIST OF ALL SPECIES RECORDED 1906-1975 (Number of species in brackets).

1) **Species which breed and are resident, and whose status has not apparently changed. (16)**

Wren, Dunnock, Robin, Blackbird, Song Thrush, Mistle Thrush, Goldcrest, Long-tailed Tit, Marsh Tit, Coal Tit, Blue Tit, Great Tit, Starling, Chaffinch, Greenfinch, Bullfinch.

2) **Species which once bred, but which no longer occur. (7)**

Cuckoo, Tree Pipit, Wheatear, Red-backed Shrike, Whitethroat, Hawfinch, Yellowhammer.

3) **Species which once bred, but which are now occasional visitors or migrants. (8)**

Tawny Owl, Skylark, Lesser Whitethroat, Garden Warbler, Spotted Flycatcher, Rook, Linnet, Redpoll.

4) **Species which have become breeding species, or increased their numbers. (10)**

Sparrowhawk, Kestrel, Wood Pigeon, Collared Dove, Green Woodpecker, Great Spotted Woodpecker, Jay, Magpie, Crow, Goldfinch.

5) **Regular visitors, whose status has not changed. (6)**

Summer visitors: Swift, Blackcap, Chiffchaff, Willow Warbler.
Winter Visitors: Black-headed Gull, Redwing.

6) **Temporary species, breeding for a few years only. (5)**

Peregrine, Redstart, Wood Warbler, Raven, Cirl Bunting.

7) **Occasional non-breeding species, whose status does not seem to have changed. (11)**

Cormorant, Herring Gull, Lesser Black-backed Gull, Stock Dove, Meadow Pipit, Pied Wagtail, Grey Wagtail, Fieldfare, Nuthatch, Tree Creeper, House Sparrow.

8) **Species seen rarely, or as passage migrants. Where relevant the date of the record and initials of the observer are noted. (21)**

Buzzard [ACL, 1946], Moorhen [AM], Coot [AM], Curlew [AM (passage)], Snipe [AM], Woodcock (1969, 1970), Turtle Dove [ACL, 1945], Little Owl [AM (occasional): ACL, 1957], Night-Jar [HCP, AM], Lesser Spotted Woodpecker (1970), Swallow (passage), House Martin (passage), Waxwing [ACL, 1947: 1970], Whinchat [ACL, 1951], Ring Ouzel [AM], Grasshopper Warbler (1968), Firecrest (1968), Chough [HCP, 1900], Brambling [AM: 1972], Siskin [ACL, 1950: 1968, 1971], Crossbill (1967).

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BIRDS OF THE AVON GORGE

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The most important feature of the lower reaches of the River Avon is the extreme tidal range. At low or intermediate tides substantial areas of mud are exposed, providing feeding for water and wading birds. The tidal range also encourages a vigorous plant growth along the banks of the river which provides feeding and nesting sites for a number of passerine species. Thus the floor of the Gorge and the land to the north into which the river flows provides a varied and interesting bird habitat in which over one hundred species have been recorded. The Black-headed Gull is the commonest bird using this site and, on occasions, over 5,000 have been seen at one time. Other common birds include Lapwing, Redshank, Starling, Crow and Chaffinch. The position of the Gorge relative to the city brings these and other species remarkably close to the centre of the urban life of Bristol.

This paper is based on a survey carried out by the author between 1976 and 1987, a preliminary version having appeared in Rose (1985). The site surveyed consists of the River Avon and its banks from Black Rocks to Horseshoe Bend (Grid. Ref. ST 550 746 to ST 540 767) and includes the scrub and rough fields between the river and the main road (the Portway) on the Bristol side. The maximum tidal range of the river is more than ten metres, so that it changes from a freshwater stream to a substantial brackish waterway every six hours. Their is a fair amount of disturbance, mainly by local people walking over the area but, on some occasions, motorcycling along the banks and the ship traffic can cause much disruption. Recently a new path has been constructed on the west bank of the river and this has caused some extra disturbance.

In the preceding paper in this volume on the natural history of the Avon Gorge, the bird-life of Clifton Down was discussed. Although these sites are adjacent geographically, there is a considerable height and habitat difference between them and their bird populations are largely distinct. Some of the gulls which feed on the river roost on the Downs at high tide and Jackdaws use both sites regularly from their nests on the cliff face. However, the typical water and wading birds seen on the floor of the Gorge never occur on the Downs. Further, although a number of passerine species occur at both sites, there is no evidence of any regular movement between them, although the corvids do provide an exception to this.

Over the past forty years considerable efforts have been made to clean up the River Avon - see Taylor (1988). This will have encouraged the fresh water species, Redshank and Common Sandpiper for example, to use the Gorge more regularly. On the other hand the scavengers, Herring Gull being the most important, have mainly moved elsewhere.

As will be noted from the systematic list below, both the largest number of species and of individual birds are present in the winter months. The general disturbance along the banks contributes to the fact that not many species breed, while the large tidal range can destroy the nests of ground-nesting birds. Some spring and autumn passage occurs but only in very small numbers so that, for example, a few Wheatears and chats may be seen at this time. Most birds are seen between September and March. The area is particularly important during very cold spells when it remains largely ice-free and there is some protection from severe wind conditions. During these spells some diving ducks, Snipe and some finch flocks several hundred strong have been recorded.

BIRDS OF THE AVON GORGE

SYSTEMATIC LIST

LITTLE GREBE One record: single bird on 29th August 1978.

CORMORANT Occasionally seen on mud or in flight, using the Gorge as a fly-way between the Severn Estuary and the South Avon reservoirs.

GREY HERON Noted regularly fishing on the water's edge.

MUTE SWAN One or two birds noted in most years.

WHITE-FRONTED GOOSE A skein of 40 birds was seen in flight on 15th. January 1979 during very cold weather.

CANADA GOOSE One record: single bird flying up river on 11th. October 1977.

SHELDUCK Occasionally up to six on the river but only in the summer months.

WIGEON A few are recorded in very cold conditions.

TEAL Surprisingly scarce: only eleven records with a maximum of six birds.

MALLARD The only duck seen regularly. The table gives the average of the monthly counts for the period of the survey.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
34	58	16	6	5	8	1	19	39	62	64	73

POCHARD and TUFTED DUCK Up to 12 birds have been seen but only in cold weather.

RED-BREASTED MERGANSER One record of a male on 5th February 1979 during a cold spell.

GOOSANDER One record: two immature birds on 19th January 1985.

SPARROWHAWK Occurs fairly regularly, breeding at four sites within a kilometre of the river.

KESTREL Regularly seen hovering over the river bank. It breeds in the vicinity.

MERLIN One record: a juvenile seen in January and February 1978.

PEREGRINE Not recorded during the survey but it did breed in the 1930's. Very recently one or two birds have again been seen in the Gorge.

RED-LEGGED PARTRIDGE One record of a single bird on river bank in March 1978.

PHEASANT Regularly seen or heard; breeding was recorded in the sixties.

COOT and MOORHEN Two records of each in very cold weather.

RINGED PLOVER Up to six birds have been noted on eleven occasions, usually in cold conditions.

LAPWING Common on the mud and in the adjoining fields except in the breeding season. The table gives the average monthly counts for the period of the survey.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
73	59	7	-	-	12	62	100	83	58	68	83

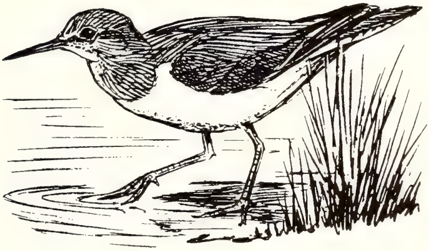
DUNLIN Surprisingly this species was noted on fewer than ten per cent of visits, mainly in cold weather. Very occasionally flocks of over 100 birds have been recorded. There is some evidence of a decline; Davis (1936) described this species as 'regular in the Avon Gorge area'.

RUFF Noted on five dates, usually singly but three were seen in April 1976.

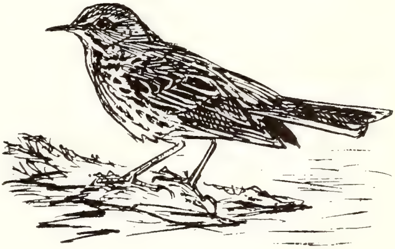
JACK SNIPE Four records, in January or February 1979, 1981 (2), 1985 and 1987.

SNIPE One or two are seen irregularly, but during winter 1984/85 up to 15 were present.

CURLEW This species is recorded less regularly now than formerly and this is probably due to the increased disturbance on the west bank. It is mainly seen in the winter months with flocks not exceeding 30 birds.



COMMON SANDPIPER



MEADOW PIPIT

REDSHANK This is the commonest wader on the river. Birds leave in late March to breed elsewhere and return now in late June; ten years ago they did not return until early September. The table gives the average monthly counts for the period of the survey.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
71	85	66	2	1	11	9	[illegible]	64	95	83	85

GREENSHANK Single birds have been noted on 25th October 1979 and in September and October 1983.

COMMON SANDPIPER This species has been recorded in all months although in the winter birds sometimes move upriver to Hotwells. The table gives the average monthly counts for the period of the survey.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	5	3	-	2	6	3	2	1	1

Until the 1930's, wintering in northern Europe was rare, then single birds began to appear at some sites. The Avon Gorge has been one of these favoured sites since December 1949 when the first wintering bird was seen in the county of Avon.

BLACK-HEADED GULL By a wide margin this is the commonest species using the site and numbers have increased considerably in the last thirty years; see the Introduction to the Avon Bird Report for 1980 (Taylor, 1981). The table gives the average monthly counts for the period of the survey.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1220	1010	790	110	65	200	480	690	1170	660	960	1370

COMMON GULL This species is regular in small numbers (up to 15) in winter.

LESSER BLACK-BACKED GULL Up to 29 birds have been seen regularly with no noticeable variation through the year. This gull has also increased in numbers over the past thirty years - see Taylor (1981).

HERRING GULL Numbers of this species vary considerably with no particular pattern; up to 135 have been noted in June. Unlike the previous three species there has been a large decline in the numbers using the Gorge - see Taylor (1981).

ICELAND GULL One record, a single bird noted on 12th April 1983.

GLAUCOUS GULL One record, a single bird noted on 6th February 1978.

GREAT BLACK-BACKED GULL One or two are recorded in most years.

KITTIWAKE One record, an immature bird noted on 5th January 1984 which was probably a casual storm-blown visitor.

COMMON TERN One record, a single bird on 12th May 1979.

FERAL PIGEON Regular.

STOCK DOVE Is seen occasionally, more so recently.

WOOD PIGEON A common species which breeds in the Horseshoe Bend area.

COLLARED DOVE Recorded on most visits.

BARN OWL Only one record of this now uncommon species near the Horseshoe Bend on 29th November 1982, though it used to breed regularly in the area fifty years ago.

SWIFT Regular in small numbers in summer.

KINGFISHER This species has been recorded on four occasions; October 1977 and 1979, August 1983 and September 1987. As it breeds on the Trym it is surprising that it has not been seen more often.

GREEN WOODPECKER Regularly seen; it breeds at two sites.

GREAT SPOTTED WOODPECKER Recorded in January 1977, June 1978 (2) and February 1979.

SKYLARK One or two are noted occasionally in winter.

SWALLOW Summer visitor which feeds regularly over the river, though it does not breed locally.

HOUSE MARTIN A common summer visitor, breeding on a number of houses near the Trym.

MEADOW PIPIT Regular, with up to 20 birds at times; it does not breed here.

ROCK PIPIT Up to four birds are normally present around the mouth of the Trym in winter.

YELLOW WAGTAIL One record of this increasingly scarce summer visitor: a single bird on 18th April 1984.

GREY WAGTAIL One or two birds are occasionally seen near the mouth of the Trym.

PIED WAGTAIL A regular but non-breeding species with up to ten birds often present.

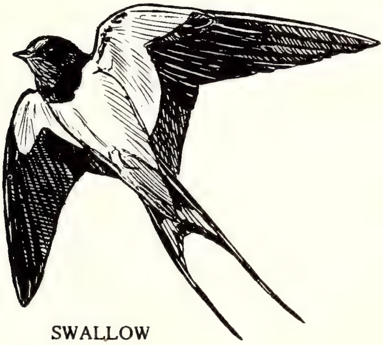
WREN A common breeding and wintering species with up to five birds seen on most visits.

DUNNOCK Occasionally seen in the scrubby areas.

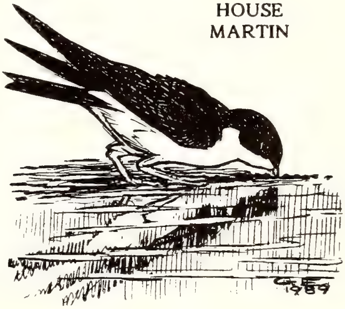
ROBIN Regular in small numbers throughout the year.

NIGHTINGALE One record: a male singing from 8th to 12th May 1984.

REDSTART One record: a male on 4th September 1981 with other chats near smouldering grass.



SWALLOW



HOUSE MARTIN

WHINCHAT Single birds in April 1978 and in May 1980 with two in September 1980 and September 1981.

STONECHAT Up to three were seen regularly in the winter months of 1976, 1977 and 1978, then single birds in November 1980, September 1981, October 1984 (2) and November 1984. This drop in numbers follows a national pattern - see Rose (1986).

WHEATEAR One or two are noted in most years on spring and autumn passage.

BLACKBIRD A common breeding and wintering species.

FIELDFARE This species occurs irregularly in winter. Over 100 were present in November 1987.

SONG THRUSH Noted once or twice each year but probably under-recorded.

REDWING Seen in most winters with up to 20 birds. A male in full song was present in April 1978.

MISTLE THRUSH This species is only an occasional visitor.

GRASSHOPPER WARBLER One record: a single bird reeling on 30th April 1981.

REED WARBLER One record: a single bird on passage on 13th September 1984.

Sylvia Warblers Lesser Whitethroat, Whitethroat, Garden Warbler and Blackcap breed in most years, the last species also occurring in winter.

CHIFFCHAFF A regular breeder, also noted on passage; one winter record of a single bird in February 1977.

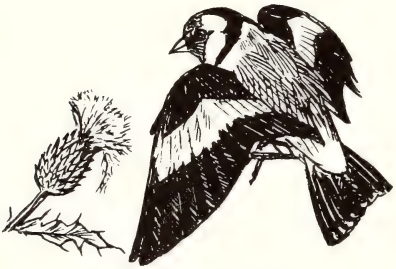
WILLOW WARBLER A common breeding and passage species.

GOLDCREST This species is noted occasionally feeding in conifers.

SPOTTED FLYCATCHER Two were seen in 1977, but it is probably under-recorded.

LONG-TAILED TIT Noted occasionally, sometimes up to thirty birds in late autumn.

MARSH TIT Three records consisting of single birds in July 1976, March 1978 and November 1987.



GOLDFINCH

STONECHAT

COAL TIT Noted on four dates only.

BLUE and GREAT TIT Both species are regular all the year round.

NUTHATCH One record of a single bird in July 1978, but almost certainly under-recorded.

JAY Regular in small numbers, often seen crossing the river.

MAGPIE Common, with up to ten birds often seen.

JACKDAW There is a breeding colony on Black Rocks with usually about twenty pairs and it is present throughout the year.

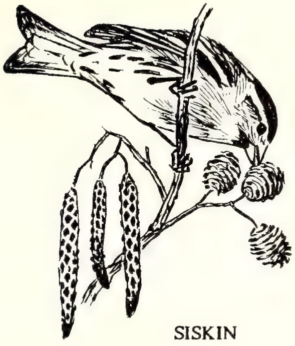
ROOK Noted only once or twice a year with usually less than five birds.

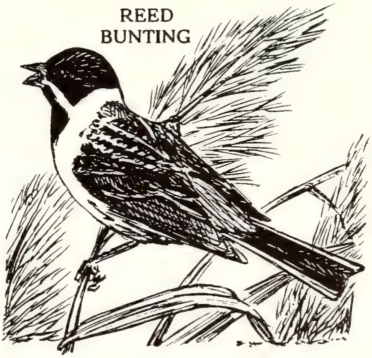
CARRION CROW This is a common species often seen feeding on the mud. A Hooded Crow was seen on 11th March 1977.

STARLING At all times this is a very common species.

HOUSE SPARROW Regularly seen around the mouth of the Trym.

CHAFFINCH Up to 150 winter regularly, also there are usually about ten





breeding pairs.

BRAMBLING This species was recorded in four winters with up to twelve birds in February 1984.

GREENFINCH and GOLDFINCH Up to 15 of each species are regularly noted.

SISKIN Recorded only in two winters but up to 120 were noted in February 1986 during an influx into the county.

LINNET Often up to 30 birds are present but it does not breed.

TWITE One record of a single bird on 26th January 1985.

BULLFINCH This species has been seen occasionally but not recently.

YELLOWHAMMER One or two were noted in the winter of 1976/77 and also in June 1978 and May 1979.

CIRL BUNTING Not recorded during the survey. A small number formerly bred in the Horseshoe Bend area but, following a national trend, not since 1971 (see Kemp, 1983).

REED BUNTING Noted regularly in winter with up to 30 birds present; it may breed.

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NOTES ON THE ENTOMOLOGY OF THE AVON GORGE

by A.H. Weeks

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and K.H. Poole

(51 Ashcombe Park Road, Weston-super-Mare BS23 2YF)

The mixed woodlands and grassland flanking the Avon Gorge provide a fine range of habitats for rich insect faunas, but there are other areas in Avon and N. Somerset which probably support a greater number of species. These include Great Breach Wood (south of Street), the area around Cheddar Gorge, the northern slopes of the Mendips from Dolebury Warren east to Burrington Common, and Broadfield Down (from Bourton Combe in the east, through Brockley Combe to Goblin Combe in the west). All but the first of these provide south-facing limestone outcrops and cliffs set in mixed woodland and grassland. Members of the Entomological Section of Bristol Naturalists' Society carried out a survey on the western side of the Gorge (Leigh Woods) from 1977 to 1982 and some of their observations are given below.

LEPIDOPTERA

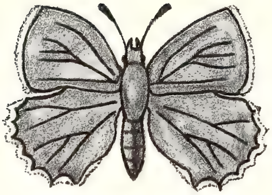
Prior to 1939, Leigh Woods, being so close to Bristol, were a kind of Mecca for local lepidopterists, as can be seen on inspection of collections in the City Museum. A.H. Peach, one-time President of the Entomological Section of the Society, contributed 'A List of Lepidoptera from Leigh Woods' to the 1938 Proceedings " .... species I have personally taken or observed ..... from 1925 to 1938". The moths listed number over two hundred, with eighteen butterflies. Micro-lepidoptera were not included.

A) BUTTERFLIES by A.H. Weeks

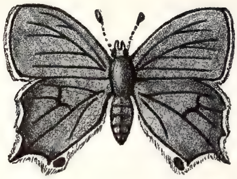
A list of the 25 species of butterfly recorded over the period 1977 to 1982 is appended. From it can be seen that all the commoner whites and yellows (family **Pieridae**) and the vanessas (family **Nymphalidae**) were present. Most of these need no description; these notes are therefore confined to specific pertinent matters.

The members of the family **Nymphalidae** recorded included the Red Admiral and the Painted Lady, both immigrant species from the Mediterranean and variable in numbers from year to year. The great majority of these species seen during the season are visitors, but both species will over-winter in this country in the adult form, provided the insects can find suitable shelter from excessive cold and damp. The cavities in the rocks in the Gorge obviously provide such shelter for, on numbers of occasions, both species have been seen in early spring flying along the south-facing cliffs on sunny days, enjoying the radiant heat provided by the rocks. In the same family are the fritillaries, of which only the Silver-washed Fritillary has been recorded. This species is found where oaks flourish, for the female has a preference for laying her eggs in cracks in the bark of oaks.

Some years ago, one could stand at the south end of the Suspension Bridge in mid-July and early August and watch the White-letter Hairstreak flying there in abundance - a delight no longer available. The food plant of the larva of this



Purple Hairstreak
(Quercusia quercus)



White-letter Hairstreak
(Strymonidia w-album)

species is elm and when the Dutch Elm disease disaster struck, this insect suffered a catastrophic decline. However, a good deal of scrubby elm survives and on this a few White-letter Hairstreaks do likewise. The only other hairstreak observed has been the Purple Hairstreak, the larval food plant being oak.

Two species which do not appear on the list, which both like rough grass on rocky outcrops, are the Wall Brown (**Lasiommata megera**) and the Grayling (**Hipparchia semele**). It is possible that both are present in the Gorge, the former in May and August, the latter in July and August and a careful season-long watch might reveal their presence. Also not listed are those two very variable immigrants, the Clouded and Pale Clouded Yellow, although in "good" years (1983 was the last such), they too can no doubt be seen in, and on the fringes of, the Gorge.

SYSTEMATIC LIST

LEPIDOPTERA

RHOPALOCERA : BUTTERFLIES

PIERIDAE

Pieris brassicae	(Large White)
P. rapae	(Small White)
P. napi	(Green-veined White)
Anthocharis cardamines	(Orange Tip)
Gonepteryx rhamni	(Brimstone)

NYMPHALIDAE

Inachis io	(Peacock)
Vanessa atlanta	(Red Admiral)
V. cardui	(Painted Lady)
Aglais urticae	(Small Tortoiseshell)
Polygonia c-album	(Comma)
Argynnis paphia	(Silver-washed Fritillary)

SATYRIDAE

Melanargia galathea	(Marbled White)
Maniola jurtina	(Meadow Brown)
Aphantopus hyperantus	(Ringlet)
Pyronia tithonus	(Gatekeeper)

Coenonympha pamphilus	(Small Heath)
Pararge aegeria	(Speckled Wood)

LYCAENIDAE

Quercusia quercus	(Purple Hairstreak)
Strymonidia w-album	(White-letter Hairstreak)
Lycaena phlaeas	(Small Copper)
Celastrina argiolus	(Holly Blue)
Polyommatus icarus	(Common Blue)
Lysandra coridon	(Chalkhill Blue)

HESPERIIDAE

Thymelicus sylvestris	(Small Skipper)
Ochlodes venatus	(Large Skipper)

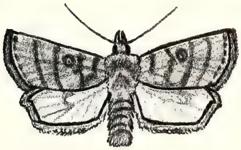
B) MOTHS by K.H. Poole

Leigh Woods is the largest area of mixed woodland close to Bristol and it supports a rich insect fauna; as noted above, it was a great attraction for lepidopterists between the wars. Leigh Woods was formerly the only British locality for **Sabre harpagula** (Scarce Hook-tip) but this species has not been seen in the area since 1938 or 1939. In recent years however, it has been found in the Wye Valley where it still occurs. **Endromis versicolora** (Kentish Glory) is said to have been found here many years ago (A.E. Hudd, Victoria County History of Somerset), but Scotland is now its last stronghold in Britain.

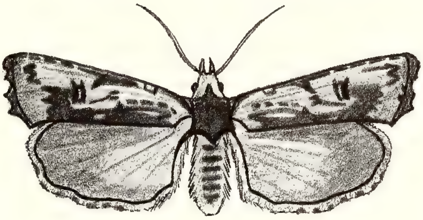
Day-time observations and light-trapping in 1974, 1975, 1976, 1977-80 and 1987 by members of the Entomological Section of the Bristol Naturalists' Society have produced a total of 264 species (not including "micros"). Thirty of the species on the 1938 list have not so far been noted, including **Peridea anceps** (Great Prominent), **Polychrysia moneta** (Golden Plusia) and **Trichopteryx polycommata** (Barred Tooth-stripe), though they may well still be present.

The most interesting recent discovery is that of **Callimorpha dominula** (Scarlet Tiger) in 1982 in larval form on April 10th and as a moth on July 10th, a welcome return following A.H. Turner's remark in the Lepidoptera of Somerset, 1955 that "There are no recent records - probably now extinct in the county". We also have a record for Batheaston, July 1980. Other species of note NOT in the 1938 list are as follows:-

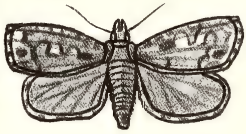
Tethea ocularis (Figure of Eighty), **Tetheella fluctuosa** (Satin Lutestring),



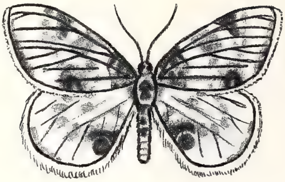
Orange Sallow
(Xanthia citrago)



Red Sword-grass
(Xylena vetusta)



Pine Beauty
(Pandis flammea)



Clouded Magpie
(Abraxas sylvata)

Archiearis parthenias (Orange Underwing), a day-flyer, usually seen high around birches in early spring, **Geometra papilionaria** (Large Emerald), **Cyclophora punctaria** (Maiden's Blush), **Euphyia unangulata** (Sharp-angled Carpet), **Selenia lunularia** (Lunar Thorn), **Lycia hitaria** (Brindled Beauty), **Hylaea fasciaria** (Barred Red), **Eilema deplana** (Buff Footman), also newly recorded in recent years from Brockley and Goblin Combes, **Anaplectoides prasina** (Green Arches), **Polia nebulosa** (Grey Arches), **Panolis flammea** (Pine Beauty), **Xylena vetusta** (Red Sword-grass), **Dichonia aprilina** (Merveille du Jour), **Xanthia citrago** (Orange Sallow), **Apamea ophiogramma** (Double-lobed), 1987 - appears to be a first record, **Celaena leucostigma** (The Crescent), **Laspeyria flexula** (Beautiful Hook-tip). Two wych-elm feeders, **Discoloxia blomeri** (Blomer's Rivulet) and **Abraxas sylvata** (Clouded Magpie), thought to be in some danger, are still present, being recorded in 1987.

These recent lists are by no means exhaustive, and further investigation should be rewarding.

ORTHOPTERA

ORTHOPTERA RECORDED FROM LEIGH WOODS, 1977-82 by K.W. Miller

No unusual observations were made and the species seen can also be found in the Gordano Valley and on the Somerset Levels.

SYSTEMATIC LIST

ACRIDIDAE

* **Chorthippus albomarginatus** (Deg.)	(Lesser Marsh Grasshopper)
C. **brunneus** (Thun.)	(Common Field Grasshopper)
C. **parallelus** (Zet.)	(Meadow Grasshopper)

TETTIGONIIDAE

* **Conocephalus dorsalis** (Latr.)	(Short-winged Cone-head)
Pholidoptera griseoaptera (Deg.)	(Dark Bush Cricket)
Meconema thalassinum (Deg.)	(Oak Bush Cricket)
Leptophyes punctatissima (Bosc)	(Speckled Bush Cricket)

* Both these species, which normally occur near water, were recorded below Leigh Woods near the River Avon. The others were found in suitable habitats throughout the area.

PAST PRESIDENTS

WILLIAM SANDERS	1862
HENRY E. FRIPP	76
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Professor C. LLOYD MORGAN	90
Professor ADOLPH LEIPNER	93
Professor SYDNEY YOUNG	94
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MEMBERSHIP OF THE BRISTOL NATURALISTS' SOCIETY

The Society welcomes applications for membership from anyone interested in natural history. The annual subscription for full membership is currently £6.50: for members of the household of a full member the rate is £3.00. For those living outside a radius of 20 miles from Bristol city centre, a reduced rate of £4.00 applies. If you are under 21 years of age associate membership is available at £5.00. The rate for juniors is £2.00. A prospectus which sets out the details and benefits of membership, and summarises the activities of the Society, may be obtained from the Hon. Treasurer:—

PHILIP J.M. NETHERCOTT
6 HAZELWOOD ROAD, HAZELWOOD COURT,
BRISTOL BS9 1PU.
Telephone: Bristol (0272) 683813

PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY

The Society has stocks of back numbers of most annual parts of the *Proceedings* which may be purchased. In addition, a Centenary History of the Bristol Naturalists' Society, 1862–1962, being Part IIIA of *Proceedings*, 1962, price 25p postage extra, is still available. Application should be made to the Honorary Librarian, Bristol Naturalists' Society, Bristol City Museum, Bristol BS8 1RL.

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NATURE IN AVON

PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY, 1988

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NATURE IN AVON

THE PROCEEDINGS OF THE BRISTOL NATURALISTS' SOCIETY

VOLUME 48

1988

EDITED BY A.E. FREY
ASSISTED BY A COMMITTEE

"Rerum cognoscere causas"—Virgil

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COUNCIL, 1988

President: Dr T.E. Thompson, D.Sc., F.Z.S.

Past Presidents:

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Hon. Bulletin Secretary:	D.W.B. Frost
Hon. Publicity Secretary:	- vacant -
Hon. Circulation Secretary:	Miss S.M. Garden
Chairman, Field Committee:	Mrs V.J. Kenney
Hon. Secretary, Field Committee:	Miss R.C. Lee, Dip. Soc. Stud.
Hon. Librarian:	- vacant -
Hon. Editor:	A.E. Frey, B.A.
Hon. Conservation Liaison Officer:	Miss I.F. Gravestock, B.A.

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	- **Hon. Secretary:**	A.C. Titchen
Entomological	- **President:**	A.H. Weeks
	Hon. Secretary:	G. Best
Geological	- **President:**	D.E.G. Briggs, Ph.D.
	- **Hon. Secretary:**	P.R. Crowther, Ph.D.
	- **Hon. Field Secretary:**	D.A. Wilson
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P.J. Chadwick
Mrs G.R. Hamilton
Mrs M. Hamilton
Miss M.E. Jervis, M.A.
C. Little, Ph.D.
N. Malcolm, M.D.
M. Martin, Ph.D.
F.H. Rawlings

REPORT OF COUNCIL, 1988

Membership at the end of the year stood at 542.

At the Annual General Meeting the Officers and Members of Council were elected with Dr T.E. Thompson continuing as President.

Council met seven times during the year.

The Annual Buffet Supper took place in April when Mr Gordon Bland, Head Gardener of Bristol Zoological Gardens, spoke on "The Bristol Zoological Gardens". Once again, a successful second-hand bookstall was held in aid of the Society's funds.

The first Portman Wessex Natural History Colour Slide Competition was organised by Mr D.W.B. Frost and the Filton Camera Club. 466 slides were entered and 150 were shown at the public showing on 16 April, when the awards were presented. An overall profit of £192 was shared between the Society and the Filton Camera Club. The event was sponsored by the Portman Building Society.

The Hector Hockey Fund made awards to the Wetmoor Nature Reserve Committee to cover the cost of setting up a Nature Trail; to Mr P. Rock in support of a long-term study of the gull colonies on Bristol roof-tops and to the Avon Ornithological Group to cover publication costs of bird distribution maps. Residual monies received from the Hector Hockey Fund amounted to £809.

The family walks for the 'Walking in Avon' programme were co-ordinated by Mr S.M. Taylor and resulted in the Society receiving the sum of £30 from Avon County Council.

The Society records with gratitude a gift of £490 from Mrs Williams and friends in memory of her husband.

We record with regret the deaths of Mrs E.B. Hills and Mr R.G. Williams during 1988.

ACCOUNT OF GENERAL MEETINGS, 1988

January:	"The Natural History of Ladakh", by Dr H.A. Osmaston.
February:	"Badgers in Britain, their Distribution and Ecology", by Penny Cresswell.
March:	"Gorges, Mountains, Stone Forests and Geologists in S. China", by Dr J.W. Cowie.
October:	"The Wildfowl Trust - Where from and where to?", by Dr Brian Bertram (Director, Wildfowl Trust, Slimbridge).
November:	"Geology comes into its own", by Dr D. Bassett.
December:	"National Trust Gardens", by Miss R.C. Lee.

AUDREY HECKELS, **Hon. Secretary**

GENERAL FIELD MEETINGS, 1988

A full account of the following meetings is kept in the records of the Field Committee:

19 Mar Mrs N. Vaughan Davies. Chepstow Park Wood. An interesting visit to a large area of mixed woodland, with conifers predominating. The growth and bark of various trees was noted, also early spring flora. The weather was disappointing, so no good views. A very muddy walk from Tintern to Brockweir in the afternoon.

1 Apr Miss R.C. Lee. Queen's Wood, near Dymock. An interesting two mile walk around the Nature Trail. Wild Daffodils and other early flowers were seen and a few birds heard singing. The walk was followed by a visit to St Mary's Church at Kempley to view the frescoes and murals which are over 600 years old. Thence to the 13th century manor house 'Hellens' at Much Marcle for a tour of the house.

4 May Mr D.A.C. Cullen. Ozleworth. A pleasant spring evening walk along a Cotswold valley, with plenty of early spring flowers and some common birds, but only a few Swallows and no Swifts or House Martins.

21 May Miss J. Lovell. Dunkery Beacon and Horner Woods, Exmoor. A four mile walk in glorious sunny weather. Some heathland and woodland birds heard and a few seen. A herd of Red Deer were seen in the distance. Many woodland plants, rushes, sedges and grasses were identified.

25 Jun Drs N. Malcolm & J. Rees. Cherhill Down and Morgan's Hill, near Calne. A most successful visit to an area of chalk downland to see typical flora. Eleven species of orchid were seen, also Round-headed Rampion, Larger Wild Thyme, Chalk Milkwort and a few Juniper bushes. True summer weather and magnificent views.

2 Jul Dr N. Webb. Fontmell Down, near Shaftesbury. An excellent day with unexpected dry weather and fine views. A circular walk on which many flowers were seen, including seven orchid species, Clustered Bellflower and other typical species of chalk downland. Despite the wind some butterflies were seen including Speckled Wood, Small Heath, Ringlet, Small Tortoiseshell and Dark Green Fritillary. A very rewarding visit to an important area.

10 Sep Mr D.A.C. Cullen. Hengistbury Head, near Christchurch. A very good day observing bird migration. Those seen included House Martins and Swallows leaving the headland and many waders on mud in Christchurch Harbour, including a flock of 27 Bar-tailed Godwit. Very few butterflies were seen. The day was dry but cool and windy.

22 Oct Miss S.M. Garden. Neroche Forest, near Taunton. A very successful final meeting of the year. Autumn colours beginning well, though not at their peak, and over 35 species of wild flower still in bloom. Deer slots observed on path, but very few birds about.

RACHEL LEE, **Hon. Secretary, Field Committee**

REPORT OF THE BOTANICAL SECTION, 1988

At the Annual General Meeting, held in the Schools Room of the Bristol City Museum & Art Gallery on 25 January 1988, the following were elected:- **Hon. President:** Mr R.M. Payne; **Hon. Secretary & Treasurer:** Mr A.C. Titchen; **Committee:** Mr A.L. Grenfell, Dr C.M. Lovatt, Mr M.A.R. Kitchen, Mrs C. Kitchen, Miss I.F. Gravestock, Mrs N. Vaughan Davies, Mr P.J.M. Nethercott, Mrs M.A. Silcocks, Ms L. McDonnell and Mr P.J. Martin.

During the year we lost the valuable services of Dr C.M. Lovatt who took up an appointment in Kenya: we thank him for his past services and wish him every success in his new career. Dr N. Malcolm kindly accepted our invitation to join the Committee.

We are indebted to the City Museums & Art Gallery for the use of the Schools Room for our indoor meetings: this has proved ideally suited to our needs.

The following winter meetings were held:-

25 Jan	Annual General Meeting & Members' Evening.
29 Feb	"My Work with the Rare Plants of S. England", by Lady FitzGerald.
28 Mar	"Canary Island Flora", by Mr R.M. Payne.
27 Oct	Members' Evening with slides.
24 Nov	"Ferns of Somerset", by Mr R.M. Payne.

The following field excursions took place, under the leadership of those shown:-

17 Apr	Brandon Hill, Mr A.C. Titchen.
22 May	The Avon Gorge, Dr C.M. Lovatt.
15 Jun	Conham and Bank of the Avon, Mr P.J.M. Nethercott.
18 Jun	Walton Down, Mrs M.A. Silcocks.
9 Jul	Wavering Down, Mr P.J.M. Nethercott.
15 Jul	Old Portishead, Mrs H. Titchen.
23 Jul	Compton Martin, Mr R.M. Payne.
17 Aug	Stoke Bishop ivies, Miss I.F. Gravestock.
21 Aug	Tytherington Down, Mr M.A.R. Kitchen.
4 Sep	Bridgwater Common, Ms L. McDonnell.
6 Nov	Fungus Foray, Leigh Woods, Mr J.G. Keylock.

TONY TITCHEN, **Hon. Secretary**

REPORT OF THE ENTOMOLOGICAL SECTION, 1988

With the exception of an Extraordinary General Meeting on 5 December, there was no indoor meeting during the year.

Five field meetings were held as follows:-

23 Apr Dolemoor, Congresbury (joint meeting with the Avon Wildlife Trust, Cadbury Hill Group).

2 May Velvet Bottom, Charterhouse-on-Mendip (photographic safari).

19 Jun Tintern, disused railway track.

8 Jul Wyndcliff picnic area, Wye Valley.

16 Jul Cleaves Wood, Wellow.

The second, third and fourth of these gained little support, so continuing the downward trend in attendances of previous years.

Six members attended the Extraordinary General Meeting which was called to discuss the suspension of the Section. No nominations for officers having been received, there was no alternative to suspension. However, three former officers agreed to act in a holding capacity; one to deal with correspondence on entomological matters, another to receive records for 1988 and the third to contribute entomological notes for the Bulletin.

GRAHAM BEST, **Acting Hon. Secretary**

REPORT OF THE GEOLOGICAL SECTION, 1988

At the Annual General Meeting held on 20 January 1988, Dr D.E.G. Briggs continued in office as President and the following were elected: **Vice-President:** Dr. D. Hamilton; **Hon. Secretary:** Dr P.R. Crowther; **Hon. Treasurer:** Mr D.A. Wilson: **Hon. Field Secretary:** -vacant- ; **Committee:** Mr S. Carpenter, Mr D. Cope, Mr M. Curtis, Mr V. Dennison, Mrs G. Hamilton, Dr P. Hardy and Mrs M. Poolman.

The following winter indoor meetings were held:

20 Jan Annual General Meeting followed by the Presidential Address, "Monsters, Myths and Medusae: some extraordinary fossils", by Dr D.E.G. Briggs.

17 Feb "The Geology of the Grand Canyon", by Dr D. Elliott.

16 Mar "The Geological Evolution of North Greenland", by Dr R.E. Bevins.

19 Oct "The Great Sea Dragons", by Dr B. Halstead.

16 Nov "Hot Ice; the Cretaceous of Antarctica", by Dr D. Macdonald.

14 Dec Members' Evening.

The following field meetings were held:-

12 May Lower Carboniferous shallow water environments at Middle Hope, Portishead and the Avon Gorge, Mr T. Faulkener.

19 Jun The beach and cliffs at Kilve, Mr D.A. Wilson.

17 Sep Fossil fauna of the Kimmeridge Clay at Westbury, Wiltshire, Ms S. Swansborough.

PETER CROWTHER, **Hon. Secretary**

STATEMENT OF ACCOUNTS FOR THE YEAR ENDED 31 DECEMBER 1988

Inome and Expenditure for the year ended 31 December 1988

1986	Income	1987
3176	Members' Subscriptions	3263
298	Income Tax repayment	266
67	Donations	232
264	Sale of Proceedings and grants	333
328	Sale of books and journals	222
108	General Field Meetings and Buffet Supper (profit)	-
-	Photographic Competition	96
217	Bank Interest	202
4458		4614
	Expenditure	
859	Printing and Stationery	950
450	Postage and Telephone	503
1524	Proceedings and Bird Report (1491 and 488)	1979
-	'The Avon Gorge' reprint	1250
150	Library, books	141
350	binding and repairs	256
153	subscriptions and purchases of journals	191
50	fire insurance and keys	80
11	Donations	11
230	Indoor Meetings	258
-	General Field Meetings and Buffet Supper losses (6 and 2)	8
165	Grants to Sections	140
3942		5767
516	Surplus on Year	-
-	Loss on Year	1153

Balance Sheet at 31 December 1988

1987			1988
	Assets		
4000	Government Stocks at purchase price		5000
941	National Savings Bank		935
525	Cash at banks - current accounts		696
3942	- interest accounts		4289
10	Prepayment		20
9418			10940
1580	**Less** Creditors (subscriptions in advance [191] Proceedings and reprint [2741] and hire of rooms [120])		3052
7838			7888
	Represented by:		
206	Harry Savory Illustrations Fund		206
93	Conservation Appeal		3
4941	Hector Hockey Memorial Fund		5744
-	R.G. Williams Fund		490
2598	General Fund at 31 December 1987	2598	
	Deduct loss on year	1153	1445
£ 7838			£ 7888

NOTES (1) No value is placed upon the contents of the Library and stocks of publications.

£ 4458		£ 4614

Special receipt not included in above accounts

Donations in memory of the late Mr R.G. Williams	490

Special Funds

Receipts and Payments for the year ended 31 December 1988

1987		1988
	Harry Savory Illustrations Fund	
206	Fund at 31 Dec 1987 & 31 Dec 1988	206
	Conservation Appeal	
93	Fund at 31 Dec 1987	93
	Additions to Fund in 1988	10
		103
	Grant to Avon Wildlife Trust (Folly Farm Appeal)	100
93		3
	Hector Hockey Memorial Fund	
4941	Fund at 31 Dec 1987	4941
	Final receipt from Glan-yr-Afon sale	809
	Year's income on investments	477
		6227
	Grants made (4)	483
£ 4941		£ 5744

(2) These accounts do not record balances held by sectional treasurers or the Ornithological Special Fund of £521.

(3) The Government stocks are £2032.10 10½% Treasury Stock 1989 and £3000 Income Bonds.

(4) Grants and donations in connection with the Proceedings 1987 but made in 1989 will reduce the lose on year by that amount.

P.J.M. NETHERCOTT
PJM Nethercott
Hon. Treasurer
12 September 1989

Audited and found correct
T.B. Silcocks
TB Silcocks
Hon. Auditor
13 September 1989

REPORT OF THE ORNITHOLOGICAL SECTION, 1988

At the 64th Annual General Meeting held on Wednesday 27 January 1988, Mr S.M. Taylor was elected **President** and Mr T.G. Evans re-elected **Secretary/ Treasurer.** Mr R. Ford and Mr R Holmes were elected as **Committee Members.** The retiring President, Dr H.E. Rose, gave his address on the Seabirds of the Western Approaches.

Five varied and interesting indoor meetings were held during the year covering Bird Song Recording, the production of the BBC TV film Under the Greenwood Tree, The Breeding Birds of Devon and Birds and Animals of the Rift Valley. A successful members' evening was also held with slides from New Zealand, California, Texas, Kenya, the Nile Valley and some interesting data for Avon. The Section also took an active part in the fieldwork meeting which this year was hosted by Bristol Ornithological Club.

Eighteen fieldwalks were arranged, some of which were included in the Avon "Family Walks" scheme.

The Section was again involved in a number of surveys during the year which included the Severn low-tide survey, the continuing 'Birds of Estuaries' enquiry, Breeding Birds survey and the continuing 'Birds of Gardens and Over-wintering Warblers' surveys. Paul Chadwick continues his European atlas work and the Sand Martin survey also continued.

Your committee held five meetings during the year.

Attendance at meetings was patchy; a disappointment was the small attendance for the excellent talk by Humphrey Sitters on the Birds of Devon. The Avon family walks were particularly well attended.

Overall, a good year but we would welcome some more younger members.

TREVOR EVANS, **Hon. Secretary**

LIBRARY REPORT, 1988

The post of Honorary Librarian has again been vacant during the year. The year's work has been one of consolidation, with routine tasks now shared out on a continuing basis amongst the Library Committee members. Our programme of binding selected journals continues with some urgent repair work also sent out. In December, there was one experimental opening of the Library for two hours on a Sunday afternoon which was possible because of a special Sunday opening of the City Museum. Throughout the year, the routine opening times of two hours on Saturday mornings and half an hour on Wednesdays have been maintained.

During the year, 198 visits have been made by 28 members who, between them, borrowed 140 items. This year, 8 books have been purchased. Currently, 13 journals (including reports and other serials) are received on subscription and 70 by exchange. Notable among gifts to the Library were 25 books given by Mrs K. Walker in memory of her husband, Jack. Seven other books and 46 journals were also donated for which we are indebted to Mr P.J.M. Nethercott, Mr D.A. Wilson, Mr S.M. Taylor, Mr A.L. Grenfell, Mr F.H. Rawlings, Mrs V.J. Kenney and Mr D.R. Atty.

We would like to express the Society's gratitude to Mr M. Heighton, Director of Arts, City of Bristol Council and to Mrs H. Woolley, Assistant Director, City Museums and Art Gallery, for the use of the Library room during the year. We are also indebted to the University Librarian for continuing to afford us some storage space for periodicals.

ANNE HOLLOWELL, **Chairman, Library Committee**

GUIDANCE FOR AUTHORS

1) The editor welcomes original papers on the natural history of the Bristol region*, which will then be considered for the Proceedings by a publications committee.

2) Manuscripts should be double-spaced with adequate margins to allow corrections and amendments. A copy should be retained by the author.

3) All items for publication should reach the editor by the end of February in each year. If there is likely to be a problem with this target date please ring the editor.

4) The Proceedings has a style and format which should be followed and it is especially important that the writing should have an abstract, be broken up by appropriate headings/sub-headings and include illustrations/photographs of a suitable nature.

5) Abbreviations should not normally be used, especially in the references.

6) References should be listed in alphabetical order at the end of the paper, and take the following form:-

Book:- AUTHOR (DATE). TITLE. PLACE OF PUBLICATION. PUBLISHER.

e.g. RACKHAM, O. (1986). The history of the countryside. London, J.M. Dent.

Article:- AUTHOR (DATE). TITLE. JOURNAL NAME, VOLUME, PART, PAGE NUMBERS.

e.g. ROSS, S.M. & HEATHWAITE, A.L. (1986). West Sedgemoor: its peat stratigraphy and peat chemistry. Proceedings of the Bristol Naturalists' Society, **44**, 19-25.

7) Originals, not copies, of photographs, slides, line drawings, diagrams and maps should be submitted - they will be returned on request. Drawings and other diagrams should be not more than twice final size and made in black medium. Photographs and slides, preferably monochrome, may be submitted as prints, positives or negatives.

8) Captions to illustrations should be appended to the end of the paper.

9) An abbreviated title for use in the running heading should be supplied.

e.g. NATURE CONSERVATION IN THE BRISTOL REGION: AN ACCOUNT OF THE WORK OF THE SOCIETY'S CONSERVATION COMMITTEE

may be abbreviated thus:-

NATURE CONSERVATION IN THE BRISTOL REGION

10) The copyright of all published material will belong to Bristol Naturalists' Society, whose Council can authorise reproduction.

11) Reprints (not covered) are available to authors at 25p per copy. Please indicate how many reprints you will require when submitting your paper.

---

* The Bristol region is construed as extending from the Vale of Berkeley in the north, the River Avon in the east and the Somerset Levels to the south, although these are at best approximate boundaries.

USEFUL INFORMATION

The President of the Society is:-

Mr R.G. SYMES
9 EDWARD ROAD WEST, CLEVEDON,
BRISTOL BS21 7DY

All articles for inclusion in the next issue of the Proceedings should be sent to:-

Dr P.R. CROWTHER, HON. EDITOR,
CURATOR OF GEOLOGY,
BRISTOL CITY MUSEUMS & ART GALLERY,
QUEEN'S ROAD, BRISTOL BS8 1RL

NOT LATER THAN 28th FEBRUARY, 1991.

See also 'Guidance for Authors' on page xii.

All Books, Pamphlets, Reports of Proceedings sent by way of exchange, gift or otherwise, and all correspondence relating thereto and to purchases of the Society's publications should be addressed to:-

HON. LIBRARIAN,
BRISTOL NATURALISTS' SOCIETY,
BRISTOL CITY MUSEUMS & ART GALLERY,
QUEEN'S ROAD, BRISTOL BS8 1RL

Applications for membership of the Society should be addressed to the Hon. Treasurer:-

Mr P.J.M. NETHERCOTT,
6 HAZELWOOD COURT, HAZELWOOD ROAD,
BRISTOL BS9 1PU

Enquiries concerning Field Meetings should be made of the Hon. Secretary, Field Committee:-

Miss R.C. LEE,
78 THE DELL, WESTBURY-ON-TRYM,
BRISTOL BS9 3UG

All other communications should be addressed to the Hon. Secretary:-

Mrs S.P. KELLY,
11 HILL BURN, HENLEAZE,
BRISTOL BS9 4RH

[Cont.

The SOCIETY'S LIBRARY is housed in the City Museum and is available to members at times which are advertised in the Society's Bulletin.

Proceedings of the Bristol Naturalists' Society (1988), **48**: xv-xix

AVON & DISTRICT ENTOMOLOGICAL REPORT, 1988

1988 was the third successive year with a poor summer and insect activity was at its lowest level for many years. The volume of records received was correspondingly small. The Section is grateful for those submitted by the members named in the following sub-sections and for some general information from the Bristol Regional Environmental Records Centre (BRERC) at the Bristol City Museum.

WEATHER SYNOPSIS (compiled by A.H. Weeks)

The winter of 1987/88 was unusually mild and damp, with very little snow in Avon and a very low incidence of frost. As early as 15 February came a day with bright sunshine, a light breeze and reasonable temperatures, which enticed into flight all four common hibernating species of butterfly and a variety of bees. After a wet March, spring was pleasantly warm and dry, although somewhat lacking in sunshine. A good fine spell starting near mid-June was unique in the summer, for July was exceptionally cool and wet and August only rather less so. July was notable in that there were only two days with maximum temperatures over 70°F (21.2°C), the extreme maximum being a mere 71.1°F (21.7°C) on the 20th. August had the highest mean temperature of the three summer months and provided the only two days of the summer with maxima over 80°F (26.6°C). The following table shows the relative merits of the months, expressed as differences from long-term averages (data provided by climatological station at Yatton).

	MONTHLY DIFFERENCES			SEASONAL DIFFERENCES	
	Max. Temp.	**% Rainfall**	**Approx. % Sun**	**Max. Temp.**	**% Rainfall**
December '87	-0.4	44	55	+1.6	
January '88	+2.9	180	90	Winter	
February	+2.3	102	190	+1.6	108
March	+0.6	173	85		
April	+0.1	86	90	Spring	
May	+1.2	84	100	+0.8	112
June	+0.5	81	80		
July	-3.5	280	85	Summer	
August	-1.4	134	85	-0.5	140
September	-0.9	96	105	Autumn	
October	+0.3	87	98	-0.1	75

The relatively better weather and increased level of sunshine of early autumn could not, of course, redress the situation and, apart from a couple of freak late sightings noted below, the season ended by the last week of October.

BUTTERFLIES (Lepidoptera) by A.H. Weeks

The small volume of records received, mostly from South Avon, makes it impossible to give a clear picture of how all resident species fared in 1988, but it does appear that the year was the poorest so far in the 1980s. The two notable features were the greater numbers of the Painted Lady seen from early spring onwards, and the return, after several seasons of scarcity, to nearer-normal numbers of the Holly Blue. Once again the populations of the common summer browns seemed to be down, as were the skippers. There was no repeat of the immigrant Clouded Yellow, nor of the more unobtrusive butterflies such as the Brown and White-letter Hairstreak. Because of the precarious state of many of our butterflies, all species seen are listed below.

Recorders:

RA	R. Angles	KHP	K.H. Poole
PJC	P.J. Chadwick	AHW	A.H. Weeks
VG	Miss V. Graham	BRERC	BRERC staff

Pieris brassicae (Large White) Common: largest numbers early August. First record, 20 April; last 23 October, both at Yatton (AHW).

P. rapae (Small White) Common, especially in May. First, 14 March at Yatton (AHW); last 2 October at Weston-super-Mare (RA).

P. napi (Green-veined White) Widespread, in smaller numbers than usual. First, 26 April at Weston-super-Mare; last 15 September at Sand Bay (RA)

Anthocaris cardamines (Orange Tip) A reasonable season. First, 22 April at Chew Valley Lake (VG); last 7 June at Sand Point (RA).

Gonepteryx rhamni (Brimstone) Reasonable numbers in spring, poorer in late summer. First, 15 February at Cleeve (AHW); last 7 September at Tog Hill (PJC) and Yatton (AHW).

Inachis io (Peacock) A reasonable season. First, 15 February at Cleeve (AHW); last 3 October at Weston-super-Mare (RA). Peak numbers in April and August - fifteen plus in garden on 16 August (AHW).

Vanessa atalanta (Red Admiral) A fair season. First, 11 May at Sand Bay (RA), last 30 October at Weston-super-Mare (RA). Most at one time, six on 16 August (AHW), six on 1 October (RA).

V. cardui (Painted Lady) Better numbers than for several years. First, 10 May at Sand Point (RA), Goblin Combe (AHW); last 29 October at Sand Point (RA). Most at one time, four on 16 June at Sand Point and five on 16 August at Yatton.

Aglais urticae (Small Tortoiseshell) Thinly spread in spring, fair numbers in summer. First, two on 15 February at Yatton (AHW); last of main flight 27 October at Weston-super-Mare, but individuals seen at Weston on 27 December and at Yatton, 28 December. Most in early August and early September.

Polygonia c-album (Comma) Widespread in small numbers. First, on 3 April at Yatton; last 29 October, same place (AHW). Most, three in Brockley Combe on 12 April (PJC), four in Goblin Combe, 20 July and four feeding on fallen plums, 5 October (AHW).

Argynnis paphia (Silver-washed Fritillary) Only two records, of three in Goblin Combe, 20 July and one, same place, 30 July (AHW).

Mesoacidalia aglaia (Dark Green Fritillary) Single report, at Uphill, Weston-super-Mare, 24 June (RA).

Clossiana selene (Small Pearl-bordered Fritillary) Two records - small numbers, 22 May at Crook Peak (RA) and 18 June at Dolebury Warren (BRERC).

Melanargia galathea (Marbled White) Plentiful locally but a short season. First, 19 June at Crook Peak (RA); last 3 August at Uphill (RA). Most at Ashcombe, Weston-super-Mare on 4 July. Also seen in Goblin Combe and Cadbury Hill, Yatton, 20 July - 6 August.

Hipparchia semele (Grayling) Single specimens, 12 July, 7 - 9 August at Uphill (RA).

Maniola jurtina (Meadow Brown) Locally common. First, 14 June at Worlebury, Weston-super-Mare; last 18 September at Ashcombe, Weston-super-Mare (RA). Peak numbers early August.

Aphantopus hyperantus (Ringlet) Smaller numbers than usual. First record, 13 July - sixteen near Dyrham Park (PJC); last 6 August at Cadbury Hill, Yatton (AHW).

Pyronia tithonus (Gatekeeper) Only a fair season and somewhat short: without the dense population of years past. First, 18 July at Sand Point (RA); last 7 September on Cheddar Valley Railway, Yatton (AHW).

Coenonympha pamphilus (Small Heath) Much less common than usual. First, 21 May at Uphill and Goblin Combe (RA, AHW); last 8 September at Aust (PJC). "Good numbers", June at Burrington Ham (PJC).

Pararge aegeria (Speckled Wood) A reasonable season. First, 23 April on the Cheddar Valley Railway, Congresbury (AHW); last 29 September at Sand Point (RA). Most, fourteen on CVR, Yatton on 7 September and twenty plus, Cadbury Hill, Yatton on 18 September.

Lasiommata megera (Wall Brown) Scarce. First, 10 May at Sand Point and Goblin Combe (RA, AHW); last 7 September at Sand Point (RA). Most, ten on 15 May at Crook Peak (RA). Also singles, 25 June at Loxton and 27 July at Weston-super-Mare (KHP).

Hamearis lucina (Duke of Burgundy Fritillary) About twenty specimens, 28 May at Midger Wood (BRERC).

Quercusia quercus (Purple Hairstreak) Three reports of single specimens; 30 July, Weston Wood (RA), 6 August, Cadbury Hill, Yatton (AHW) and 20 August, Brown's Folly Nature Reserve, near Bath (BRERC).

Callophrys rubi (Green Hairstreak) Two records only - 28 May, Midger Wood and 18 June, Dolebury Warren (BRERC).

Lycaena phlaeas (Small Copper) Relatively scarce. First, 10 May at Sand Point (RA); last 11 September, same place. A few on 21 May, Goblin Combe (AHW), 28 May at Midger Wood and 18 June. Most, four on 6 August, at Cadbury Hill, Yatton and four, Cheddar Valley Railway, Yatton on 7 September (AHW).

Aricia agestis (Brown Argus) Few records. First, 10 May at Sand Point (RA); last 11 September, same place. A few 21 May at Goblin Combe (AHW), 28 May at Midger Wood and 18 June at Dolebury Warren.

Cupido minimus (Small Blue) Only two records - 28 May at Midger Wood and 18 June, Dolebury Warren (BRERC).

Celastrina argiolus (Holly Blue) After three poor years, better numbers but still not plentiful. First, 21 April at Weston-super-Mare (RA); last on 7 August at Weston-super-Mare (KHP) and Yatton (AHW). Most - four on 6 August, Cadbury Hill, Yatton.

Lysandra coridon (Chalkhill Blue) Prime sites apparently not visited by recorders. One record - 15 August at Uphill, Weston-super-Mare (RA).

Polyommatus icarus (Common Blue) Some recovery being made from low numbers in past few years. First, 15 May at Uphill, Weston-super-Mare (RA); last 18 September at Sand Bay and Cadbury Hill, Yatton. Most, thirteen on 22 May, twenty-five plus on 6 August, both at Cadbury Hill, Yatton; fifteen on 7 September on Cheddar Valley Railway, Yatton (AHW).

Pyrgus malvae (Grizzled Skipper) Few reports. 8 - 22 May at Crook Peak (RA); five on 10 May at Goblin Combe (AHW); 28 May at Midger Wood and 18 June at Dolebury Warren (BRERC).

Erynnis tages (Dingy Skipper) Single specimens, 10 May at Goblin Combe (AHW); 22 May at Crook Peak (RA); also 28 May at Midger Wood (BRERC).

Thymelicus sylvestris (Small Skipper) Surprisingly scarce. First, 20 July at Goblin Combe; last 9 August at Uphill, Weston-super-Mare (RA). Most, four on 6 August at Cadbury Hill, Yatton (AHW).

Ochlodes venatus (Large Skipper) Greatly reduced numbers. First, 12 June at Crook Peak (RA), last 30 July at Goblin Combe (AHW).

MOTHS (Lepidoptera) by K.H. Poole

Very few records were received for 1988 and the only migrants noted, apart from the Silver-Y, were Death's Head and Humming-bird Hawk-moths.

Acherontia atropos (Death's-head Hawk-moth) Weston-super-Mare, 13 June (N. Gough, Woodspring Museum).

Macroglossum stellatarum (Humming-bird Hawk-moth) Churchill, 20 July (D. Agassiz).

Callimorpha dominula (Scarlet Tiger) Gordano Valley Reserve, 30 June, two specimens by day (D. Agassiz). The first record for this part of our area, previously noted at Batheaston, 1980 and Leigh Woods, 1982, a larva.

The following 'microlepidoptera', recorded by D. Agassiz, appear to be new for our area:-

Nemophora metallica Wellow, 16 July (Society Field Meeting).

Stephensia brunnichella Walton Down, 20 July.

Eulamprotes wilkella Berrow, 27 June.

Eudonia lineola Berrow (B. Slade per DA - no date given).

Ostrina nubilalis (European Corn-borer) Churchill, 26 June.

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BRISTOL BOTANY IN 1988

by A.J. WILLIS

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Although the weather in several months in 1988 was rather exceptional, the year was fairly average overall. The total rainfall at Long Ashton Research Station, to which all meteorological records relate, was 911.5 mm, 104% of the long-term average. However, rainfall at the start of the year and also from July to October was well above average; in contrast, April to June was dry and November and December very dry, the rainfall in December being only 20.1 mm, 24% of average and the driest since 1926. Although February was the sunniest February on record, it also brought snow, hail and gales. Temperatures were mild in January, very cool in July (the lowest maximum of 14.0°C is the lowest since 1922) and mild in December. Growing conditions were favourable at the start of the year, but less so in spring although the first half of May was very warm, dry and sunny. The unusual flowering in mid-December of some forty plants of Marsh Marigold on Tealham Moor, Somerset Levels (RSC) no doubt reflects the mild temperatures at the end of the year.

In May 1988 a report, by the Gordano Valley Project officer, Simon Barker, of the Avon Wildlife Trust, was published under the title Gordano Valley - the Future for Wildlife. This publication gives information on the physical features of the Gordano Valley, the quite wide range of habitats represented and their wild life, and the various land uses. It also considers 'A way ahead', with recommendations for management and conservation. The different types of vegetation are briefly described, reference being made to a number of notable species. However, **Ranunculus lingua** is not confined in the Bristol area to the Gordano Valley, being still present at Churchill and in the Somerset Levels where **Carex lasiocarpa** also persists. An appendix listing the plants of the Gordano Valley shows its floristic richness. To the list may be added **Rosa micrantha** (see 'Bristol Botany in 1984', p.65) and the recently discovered **Carex acuta** in Walton Moor.

The book Thomas Lawson North Country Botanist Quaker and Schoolmaster by E. Jean Whittaker published in 1986 (Sessions Book Trust, York) is of interest particularly in relation to the history of Bristol Botany. Thomas Lawson visited Bristol in the course of a substantial tour around England in 1677, and recorded details of a number of plants which he saw in a small note-book. A detailed account of items recorded is given by the late Canon C.E. Raven in the Proceedings of the Linnean Society 1947/48, Vol. 160, Pt. 1, pp. 3-12, in the article 'Thomas Lawson's Note-book'. Reference to this paper is made by the Sandwiths in 'Bristol Botany in 1950', pp. 174-5; an article by late W.R. Price in the Proceedings of the Cotteswold Naturalists' Field Club for 1948 (Vol. XXX, Pt. 1, pp. 97-99) deals with the Gloucestershire records. Among the species noted by Thomas Lawson for St Vincent's Rocks (Avon Gorge) or on the Somerset side of the river are **Veronica spicata, Trinia glauca, Viburnum lantana, Hypericum montanum, Sherardia arvensis** and **sedum forsteranum (rupestre)**. Lawson's list contains a substantial number of first records for the Bristol area.

Several records made in 1988 highlight the remarkable powers of persistence of some lesser-known species. First recorded in Leigh Woods over a century ago (in 1885) as 'one or two plants' was the Pale Sedge, **Carex pallescens**; although little recorded over the years, it is still present there in small quantity, and may be regarded as an indicator of ancient woodland (see O. Rackham Ancient Woodland, 1980, p.84). Also the Nit Grass, **Gastridium ventricosum**, recorded at Twine Hill, North Wootton, in 1883, was found again at this site in 1988 following a deliberate search. **Helleborus viridis** still persists at Woollard, although not recorded at this site for many decades (probably known there to the Sandwiths as this record is underlined, apparently according to their custom of plants seen, in their annotated copy of White's Flora of Bristol). Extended ranges are noted for **Thlaspi alpestre**, **Symphytum tuberosum**, **Epipactis phyllanthes**, **Koeleria vallesiana** and **Carex elata**, although this sedge is feared lost fom the Gordano Valley where it was last recorded in 1956. Records of hybrids include **Carex acuta** x **elata**, and of **Reynoutria**, **Rumex** and **Euphrasia.** The record of the hybrid between **Rosa rubiginosa** and **R. stylosa** is particularly notable, being the second for Great Britain. New to v.c.6 is the Sharp Rush, **Juncus acutus**, at Berrow. This Southern Oceanic species is well known in coastal areas in Devon and parts of Wales. Highly notable finds of aliens are of **Quercus castaneifolia** in the Avon Gorge, probably the first occurrence in the wild in the British Isles, and **Tribulus terrestris** in the Avonmouth Docks.

By the death in October 1988 of E.S. Smith the Society has lost a botanically-interested member who came to Nailsea in 1963 and joined the BNS in 1964. Eric Smith made a number of plant records for the Nailsea area. In May 1982, his account of 'The Botany of Nailsea' was published in the Nailsea Pennant, the Newsletter of the Nailsea and District Local History Society (Vol. 2, No. 3). This paper refers particularly to the plants of Nailsea Moor and also of stone walls of the district. Observations spanning almost twenty years show the rare flowering of Bladderwort (**Utricularia vulgaris**), which produced a mass of flowers in August 1980, and also note the changes in distribution of Water Violet (**Hottonia palustris**) and Frogbit (**Hydrocharis morsus-ranae**). Also recorded from the Nailsea area are Water Whorl Grass (**Catabrosa aquatica**), Tasteless Water-pepper (**Polygonum mite**) and the parasitic Ivy Broomrape (**Orobanche hederae**).

Names of contributors associated with several records, or with the determination of specimens, are abbreviated thus:

JMB	J.M. Boyd
JFB	J.F. Burton
PJC	P.J. Chadwick
RSC	R.S. Cropper
GGG	Rev. G.G. Graham
IFG	Miss I.F. Gravestock
IG	I. Green
PG	P. Green
ALG	A.L. Grenfell
CCH	C.C. Haworth
SCH	Mrs S.C. Holland
ACJ	A.C. Jermy
JGK	J.G. Keylock
CK	Mrs C. Kitchen
MARK	M.A.R. Kitchen
ACL	Dr A.C. Leslie
CML	Dr C.M. Lovatt
PJMN	P.J.M. Nethercott
RMP	R.M. Payne
RGBR	Capt. R.G.B. Roe, R.N.
SW	Mrs S. Wilson

G: Gloucestershire S: Somerset

For details of the area covered by this Report, see 'Bristol Botany in 1978', p.35.

Osmunda regalis L. Two small plants in area of scrub, Chilton Moor, S, RSC.

Cystopteris fragilis (L.) Bernh. On old stone wall, Mendip Lodge Wood, S, RSC.

Gymnocarpium robertianum (Hoffm.) Newman [**Thelypteris robertiana** (Hoffm.) Slosson] Two small clumps in stonework of old flue, Priddy, S, JMB and (later) RSC.

Botrychium lunaria (L.) Swartz Many plants 1-2 cm tall at disused edge of Breakheart Quarry, Stinchcombe Hill, G, M. Trotman and B. White, and (later) CK and MARK.

Helleborus viridis L. ssp. **occidentalis** (Reuter) Schiffner A single plant at side of lane, Tytherington, G, CK and MARK. A few flowering plants, laneside hedge bank and adjoining field, Woollard, S, RSC, agreeing with the site given by J.W. White Flora of Bristol, 1912, p.127.

Aconitum napellus L. ssp. **napellus** A fairly robust stand on woodland bank, Ozleworth Bottom, G, CK and MARK. Noted at this site in 1908 in Little Avon Field Club Record.

Ceratophyllum demersum L. Shipham, S, RSC.

Fumaria capreolata L. With much **F. officinalis** L., one plant on bare ground, Edington Burtle, S, RSC.

Lepidium heterophyllum Bentham Numerous plants adjoining garden, Bagstone, near Wickwar, G, CK and MARK.

L. latifolium L. A good patch on left (south) bank of ox-bow of Berkeley Pill, Berkeley Nuclear Power Station, G, CK and MARK. Previously recorded at two other sites in the Berkeley area.

Thlaspi alpestre L. A vigorous patch near dam, Priddy Pool, S, JMB and (later) RSC.

Draba muralis L. Several plants on wall-top, Chewton Mendip, S, and also Emborough, S, RMP.

Cardamine impatiens L. About a dozen plants, shaded wall-top at edge of wood, Winford, S, RMP.

Rorippa amphibia (L.) Besser Persists on the banks of the Avon at Conham, G, PJMN, where now in very small quantity and endangered by angling and work on the bank. Reported from this site in J.W. White's Flora of Bristol, 1912, p. 157, under **Armoracia amphibia** Peterm. Also at Portbury, S, RSC.

Arabidopsis thaliana (L.) Heynh. Garden weed, Stoke Bishop, Bristol, G, IFG.

Reseda lutea L. Hinton Charterhouse, S, RSC.

Hypericum maculatum Crantz With **H. perforatum** L. and **H. hirsutum** L., in good quantity, grass verges, Publow Hill, S, RSC.

H. pulchrum L. A good patch, Binegar, S; also abundant in rough grassland, Wavering Down, S, RSC.

Silene dioica (L.) Clairv. x **S. latifolia** Poiret ssp. **alba** (Miller) Greuter & Burdet

In 1987, with both parents, plentiful, Velvet Bottom, Mendip, S, JFB.

Stellaria pallida (Dumort.) Piré In 1987, Observatory Hill, Clifton, Bristol, G, CML, where previously known. Also in 1987, several plants in flower bed, Weston-super-Mare, S, RSC.

S. neglecta Weihe Charfield, G, RSC. Also East Harptree, S, RSC.

Sagina nodosa (L.) Fenzl At two places at Priddy, and also to the east in bare area adjoining ride, Stock Hill Plantation, S, RSC.

Halimione portaculoides (L.) Aellen In 1987, two patches of flowering plants on the bank of the River Avon, Shirehampton, G, RSC; not recorded at this site for many years.

Tilia cordata Miller In old coppice woodland above the River Avon, Conham, G, PJMN, where noted by J.W. White (Flora of Bristol, 1912, p. 204).

Malva neglecta Wallr. Roadside, Hallen, G, IFG.

Geranium sanguineum L. A single substantial patch and a few small outliers, Breakheart Quarry, Stinchcombe Hill, G, MARK. Alien species are present nearby and the Cranesbill may not be native here.

Medicago sativa L. ssp. **falcata** (L.) Arcangeli In 1987, two large plants on waste ground, Shirehampton, G, IFG.

M. arabica (L.) Hudson Abundant in lawn area near the Castle School, Thornbury, G, CK and MARK. Also playing fields, Stoke Bishop, Bristol, G, IFG.

Trifolium squamosum L. Several patches, Kingston Seymour, S, RSC, and also a few plants further north.

T. scabrum L. With **T. striatum** L., several flowering plants on rocky slope, Elborough, S, RSC.

Astragalus glycyphyllos L. A flowering and fruiting patch amongst nettles and scrub, Portbury, S, RSC.

Onobrychis viciifolia Scop. In 1984, flowering well, Kenn Moor, S; also frequent on Clevedon Moor, S, JFB.

Vicia tetrasperma (L.) Schreber Near the towpath of the Avon at Conham, G, PJMN. Probably the site recorded by J.W. White, 1912. Also Cheddar, S, RSC.

V. lathyroides L. Flowering well, Stert Island, S, RSC. Also **Desmazeria marina** (L.) Druce, and plentiful **Cerastium diffusum** Pers. and **C. semidecandrum** L.

Sanguisorba minor Scop. ssp. **muricata** Briq. Grassland, Catcott, S, PG, det. ACL.

Rosa rubiginosa L. A large number of plants on roadbank, Itchington, G, CK and MARK, conf. GGG.

R. rubiginosa L. x **R. canina** L. With parents, in quantity on roadbank, Itchington, G, CK and MARK, conf. GGG.

R. rubiginosa L. x **R. stylosa** Desv. In good quantity although no parents found nearby, Stinchcombe Hill, G, CK and MARK, det. GGG. This is a second record for Great Britain.

Sorbus torminalis (L.) Crantz Two 30 ft thin-trunked straight trees, in fruit, streambed, Roundhouse Wood, Hill, G, MARK. Also a single tree cut back in hedge, Bagstone, G, and several trees in remnant woodland, Crossways Wood, Thornbury, G, CK and MARK.

Sedum telephium L. In 1987, several patches flowering well on cliffs, Cheddar Gorge, S, RSC, and in smaller quantity further east and on rocks in the village. Also in 1987 several plants along old railway track, Sandford, S, RSC.

Drosera intermedia Hayne With **D. rotundifolia** L., plentiful on bare peat in recently cleared area, Street Heath, S, RSC.

Lythrum portula (L.) D.A. Webb In small quantity, dried-up trampled margins of two ponds, Whitcliff Deer Park, Ham, G, CK and MARK. Previously recorded (1981) about 800 metres from this site (by ALG, see Supplement to the Flora of Gloucestershire, by S.C. Holland **et al.**, 1986, pp.52-53, under **Peplis portula**).

Myriophyllum verticillatum L. Plentiful in ditch dominated by **Juncus subnodulosus** Schrank, Weston Moor, Gordano; also four small patches in ditch with about 50 cm water, Walton Moor, Gordano, S, SW.

M. spicatum L. West Huntspill, S, RSC.

M. alterniflorum DC. A total of twelve patches in three parts of Walton Moor, Gordano, S, SW. Flowering in a shallow ochreous peaty ditch.

Bupleurum tenuissimum L. In quantity, West Huntspill, and scattered along the raised south bank of the Brue near its mouth, S, RSC.

Petroselinum segetum (L.) Koch A few plants, West Huntspill, S, and on the south bank of the Brue near Highbridge, S, RSC.

Sison amomum L. Burledge Hill, S, RSC.

Oenanthe pimpinelloides L. In good quantity in the drier parts of Berkeley Moors, G, MARK, conf. SCH. Also **O. fistulosa** L. in quantity on the damp areas, Berkeley Moors, G, MARK, conf. SCH.

Polygonum mite Schrank Near water, laneside, Oldland, Bristol, G, IFG.

Rumex x **weberi** Fisch.-Benz. (**R. hydrolapathum** Hudson x **R. obtusifolius** L.) Bank of rhyne, Hutton, near Weston-super-Mare, S, IFG, det. Dr J.R. Akeroyd.

R. pulcher L. Several plants, near road, Downs, near Downleaze, Bristol, G, IFG.

R. sanguineus L. var. **sanguineus** Persistent on the Zigzag, Clifton, Bristol, G, CML.

Calluna vulgaris (L.) Hull The Ling is abundant on Blackdown, Mendip, now with very much less **Erica cinerea** L. and **E. tetralix** L. than given in the table (p.355) in the paper 'The Heath Association on Blackdown, Mendip, Somerset' by G.H. Heath and others (these Proceedings, 4th Series, Vol. VIII, Pt. III, 1937, pp.348-364). The reduction of Cross-leaved Heath is probably due to the present much drier condition of Blackdown. In contrast, on the Mendip upland to the west, on Wavering Down and Crook Peak, Bell Heather is common over a wide area but Ling is scarce and confined to the higher, more acidic leached ground. No suitable sites for **E. tetralix** are present on Wavering Down or Crook Peak, S, PJMN.

Centaurium pulchellum (Swartz) Druce On steep south-facing slope, Launcherley Hill, North Wootton, S, RGBR and also RSC.

C. erythraea Rafn A few of the cushion-like plants from Wavering Down (see 'Bristol Botany in 1973', p.23) and Crook Peak ('Bristol Botany in 1950', p.172) have been named as **C. capitatum** (Willd.) Borbás (see also the late N.Y. Sandwith's comments in 'Bristol Botany in 1962', pp.303-4). However, Clapham, A.R., Tutin, T.G. and Moore, D.M., in the 3rd edition of the Flora of the British Isles, 1987, p.352, refer to the very variable nature of characters such as branching and relative length of calyx and corolla, the form with a dense inflorescence and stamens at the base of the corolla tube being given only varietal status [**C. erythraea** var. **capitatum** (Willd.) Melderis]. The most usual form with erect stems is present, but in smaller quantity, on Crook Peak and Wavering Down, S, the 'dumpy' form growing in the more open stony areas, PJMN.

Gentianella amarella (L.) Börner Several sites on Wavering Down and Crook Peak, S, PJMN. Also Cleaves Wood, Wellow, S, RSC. In 1987, Velvet Bottom, Mendip, S, JFB.

Cynoglossum officinale L. Several plants, Castle Hill, Walton-in-Gordano, S, JFB.

Symphytum tuberosum L. Several large patches, bank of motorway, Severn Bridge, G, T.G. Evans.

Verbascum virgatum Stokes Flourishing near Mascall's Wood, Cheddar, S; also persistent on roadside bank, Axbridge, S, RSC.

Veronica montana L. South Stoke, S, RSC.

V. hederifolia L. ssp. **hederifolia** A casual on soil heap, Great Quarry, Avon Gorge, G, CML. Persistent on pathsides, Worle Hill, S, CML.

Linaria repens (L.) Miller Railway bank, Hallen, G, IFG.

Euphrasia confusa Pugsl. x **E. tetraquetra** (Bréb.) Arrond. Calcareous grassland, Dolebury, Churchill, S, JGK, det. Dr A.J. Silverside. A first record on Mendip.

Thymus pulegioides L. In 1987, a good patch, Henbury Hill, G. Also in 1987, several plants in old quarry, Stoke St Michael, S. In 1988, several patches in churchyard, Clapton-in-Gordano, S, and a few plants on grassy hillside, Portbury, S, all records RSC.

Stachys arvensis (L.) L. With **Euphorbia exigua** L. and **Kickxia elatine** (L.)

Dumort., in large quantity where turf recently stripped, Breakheart Quarry, Stinchcombe Hill, G, MARK.

Lamium amplexicaule L. On steps, Cheddar Reservoir, S, RSC.

L. hybridum Vill. In 1987, cornfield, Corsham, S, and also at Marksbury, S, R.D. Randall. In 1987 plentiful as an arable weed, hilltop field, near Banwell, S, CML.

Galium x **pomeranicum** Retz. (**G. mollugo** L. x **G. verum** L.) On rocky ground, Wavering Down, S, PJMN.

Sambucus ebulus L. In field hedge, Puxton, S, RSC.

Filago pyramidata L. With sparse **F. vulgaris** Lam., several scattered plants on stony slope, Fry's Hill, Axbridge, S, RSC.

Gnaphalium uliginosum L. Portbury, S, and also East Harptree, S, RSC.

Artemisia maritima L. Still on dyke, Uphill, S, IFG.

Cirsium eriophorum (L.) Scop. Flowering abundantly, edge of rough grass field, Fuddlebrook Hill, south of Marshfield, G, PJC.

Sonchus asper (L.) Hill var. **inermis** Bisch. Wayside, Stoke Bishop, Bristol, G, IFG.

Hieracium maculatum Sm. Old quarry, Binegar, S, RSC.

Crepis biennis L. In 1987, on wall, Clifton, Bristol, G, JFB.

Taraxacum subhamatum M.P. Christ. (**T. marklundii** Palmg.) Damp meadow, Chilton Moor, S, JGK, det. CCH.

T. undulatiflorum M.P. Christ. In 1975, disused railway track, Street Heath, S, JGK, det. CCH.

Potamogeton berchtoldii Fieber A large flowering patch, Mineries Pool, Priddy, S, RSC.

P. pectinatus L. Uphill, S, RSC.

Groenlandia densa (L.) Fourr. A good patch in rhyne, Axbridge, S, RSC.

Polygonatum multiflorum (L.) All. A small patch, Monk's Wood, Cold Ashton, G, RSC.

Paris quadrifolia L. Several plants, Mendip Lodge Wood, S, RSC.

Juncus ambiguus Guss. (**J. ranarius** Song. and Perr.) Plentiful on bare mud around brackish pool, Kingston Seymour, S, and salt marsh, Sand Bay, Kewstoke, S, RSC.

J. acutus L. Salt marsh, Berrow, S, M.J. Galliott, conf. RGBR. A first firm record of the Sharp Rush for v.c.6.

Leucojum aestivum L. A few flower spikes in narrow roadside grass verge at edge of copse, Failand, S, PJC, det. A.C. Titchen.

Cephalanthera damasonium (Miller) Druce A single plant, Westridge Wood, Wotton-under-Edge, G, MARK. The persistence of this species here seems precarious, as it was not seen in 1987.

Epipactis helleborine (L.) Crantz Several plants in woodland, Wick Rocks, G, PJMN.

E. purpurata Sm. The colony at Hunstrete Lake, S, RSC, flowered moderately well in 1987 but more abundantly in 1988.

E. phyllanthes G.E. Smith In 1985, towpath under Leigh Woods, Bristol, S, B.W. Hawkins. Still present in 1988, PG and IG, conf. Dr A.J. Richards.

Coeloglossum viride (L.) Hartman In fair quantity, limestone pasture, South Stoke, S, RSC.

Orchis morio L. Limestone pasture, South Stoke, S, RSC. In 1984, hundreds of plants, varying in flower colour from pinkish-lilac to deep purple, Golf Course, Failand, S, JFB.

Anacamptis pyramidalis (L.) L.C.M. Richard Roadside verge, Wraxall, S, JFB.

Scirpus sylvaticus L. In 1987, a large bed in swampy woodland, Coleford, S, RSC.

Isolepis cernua (Vahl) Roemer & Schultes Several tufts, with **I. setacea** (L.) R.Br., on almost bare peat bank of recently cleared field ditch, Walton Moor, Gordano, S, SW. Also Weston Moor, Gordano, S, RSC.

Eleogiton fluitans (L.) Link Six patches, in blocked peaty ochreous ditch, Walton Moor and a single small patch in field ditch, Weston Moor, Gordano, S, SW.

Carex vesicaria L. Berkeley Moors, G, MARK, conf. SCH.

C. strigosa Hudson Several plants in shade by stream, East Harptree Combe, S, RSC.

C. pallescens L. In 1987, in small quantity by side of damp ride, Forestry Commission part of Leigh Woods, Bristol, S, CML. This sedge was first reported from Leigh Woods in 1885; it was noted here in 1958 and in another spot in the Forestry Commission part of the woods in 1963 by PJMN. It has always been very sparse.

C. elata All. Damp pasture, Winscombe, S, Dr Bettie Thurlow, conf. ACJ.

C. acuta L. In small quantity, with **C. riparia** Curtis, in rhynes in peaty area of rough pasture, Berkeley Moors, G, MARK, conf. SCH. About a hundred fruiting shoots, blocked ditch, on thick peat with evidence of iron ochre, Walton Moor, Gordano, S, SW and Mrs M.A. Silcocks, conf. ACJ. This sedge was reported by C. Bucknall in 1918 from Walton Moor 'sparingly' (J.W. White, ms).

C. acuta L. x **C. elata** All. In 1983, ditch, Axbridge, S, D. Pearman, det. ACJ and A.O Chater.

Danthonia decumbens (L.) DC. [**Sieglingia decumbens** (L.) Bernh.] Sparingly, on higher, more acidic, leached ground, Wavering Down and Crook Peak, S, PJMN.

Vulpia myuros (L.) C.C. Gmelin Abundant along old railway track, Yatton, S; also old quarry, Binegar, S, RSC.

Puccinellia rupestris (With.) Fernald and Weatherby In small quantity on mud, landward edge of saltmarsh, Sand Bay, S, RSC.

Catabrosa aquatica (L.) Beauv. Plentiful by rhyne, Westhay Moor, S, RSC.

Koeleria vallesiana (Honck.) Gaud. Several plants, S.W.-facing rocky limestone slope, Elborough Hill, Hutton, S, RSC.

Gastridium ventricosum (Gouan) Schinz & Thell. On calcareous grassland, Launcherley Hill, North Wootton (Twine Hill), S, RGBR. This rare grass was recorded from here in 1883 by E.S. Marshall; it appears to be more widespread in Somerset than previously thought (now known also from the Rhaetic at Moorlinch, Stawell and Pendon Hill in S. Somerset).

ALIENS. **Helleborus lividus** Aiton ssp. **corsicus** (Willd.) Tutin Lane, Stoke Bishop. Bristol, G, IFG, det. ALG.

Diplotaxis muralis (L.) DC. A single plant, roadside, Stoke Bishop, Bristol, G, IFG, det. ALG.

Lunaria annua L. Thoroughly established for many years, with several young trees of **Laburnum anagyroides** Medic., on a grassy bank beside the M32 motorway, Eastville, Bristol, G, ALG.

Althaea rosea (L.) Cav. The Garden Hollyhock has long been established beside the M32 motorway at St Werburgh's, Bristol, G, ALG.

Geranium endressii Gay x **G. versicolor** L. (G. x **oxonianum** Yeo) In 1987, established under a bush, Clifton Down, Bristol, G, CML.

Impatiens glandulifera Royle Bank of the River Boyd at Wick Rocks, G, PJMN.

Robinia pseudoacacia L. Self-sown seedlings where there are planted specimens of this tree in the vicinity of White's Hill Common, Hambrook, Bristol, G, ALG.

Vicia villosa Roth ssp. **varia** (Host) Corb. Waste ground, Odd Down, Bath, S, D.E. Green, det. E.J. Clement.

Potentilla recta L. Has extended along the towpath at Conham, G, PJMN, where known for some years (see 'Bristol Botany in 1973', p.28).

Sedum album L. Plentiful on sea wall, Sand Bay, S, RSC.

S. reflexum L. Roadside, Oldland, Bristol, G, IFG.

Smyrnium olusatrum L. Banwell, S, RSC. Most records of this pot-herb are nearer to the sea.

Ammi majus L. In 1987, single plant in street, Shepton Mallet, S, CML.

Reynoutria japonica Houtt. x **R. sachalinensis** (Friedrich Schmidt Petrop.) Nakai In 1987, Observatory Hill, Clifton, Bristol, G, ACL (per CML).

Quercus x **hispanica** Lam. 'Lucombeana' In 1980, in hedgerow, Observatory Hill, Clifton, Bristol, G, a young specimen was named **in situ** as this by the late Professor J.P.M. Brenan (per CML). After further growth, the specimen is now more obviously this rather uncommon hybrid known as the Lucombe Oak.

Q. **castaneifolia** C.A. Meyer Several small saplings in blackberry and hawthorn scrub, top of the Black Rock Gully, Clifton, Bristol, G, ALG, det. J.White. This is believed to be the first record in the wild of the chestnut-leaved oak, native in forests in southern Russia, in the British Isles. Its provenance is unknown, but it may have arisen from a squirrel's horde. Details of this and of many other aliens of the Avon Gorge are given in the valuable article 'A review of the alien and introduced plants of the Avon Gorge' by ALG in these Proceedings for 1987 (Vol. 47, pp.33-44, 1989).

Verbascum blattaria L. In 1987, several plants in flower and fruit on waste ground, Shirehampton, G, RSC.

Salvia reflexa Hornem. This species was one of a fine collection of birdseed aliens growing in late summer in a drainage channel grating on the M32 motorway, St Werburgh's, Bristol, G, ALG. Although first-hand examination of these plants was not possible, **Amaranthus retroflexus** L., **Carthamus tinctorius** L., **Centaurea diluta** Aiton, **Panicum miliaceum** L. and **Setaria viridis** (L.) Beauv. were recognised through binoculars from a vantage point off the motorway.

Nepeta x **faassenii** Bergmans ex Stearn Roadside, Oldland, Bristol, G, IFG, det. ALG.

Teucrium chamaedrys L. Still present in quantity, rough pasture, Sand Point, S, IFG.

Doronicum pardalianches L. A small patch, lane, Dunkerton, S, RSC.

Crepis setosa Haller f. In 1987, with **Rapistrum orientale** (L.) Crantz, street, Shepton Mallet, S, CML.

Hemerocallis fulva (L.) L. One flowering plant, seaward margin of dune marsh, Berrow, S, RSC.

Galanthus plicatus Bieb. With **G. nivalis** L. in parish churchyard and nearby green, Thornbury, G, CK and MARK.

Iris spuria L. ssp. **ochroleuca** (L.) Dykes A garden escape in scrub on Carboniferous limestone, Sand Point, Kewstoke, S, ALG. Although known at this site from about 1950, not determined until 1988.

Lemna minuscula Herter In 1987, pool in nursery with other aquatics, Burrington, S, IG, conf. ACL. This is the first record of this Duckweed in S.W. Britain.

Bromus inermis Leyss. The Hungarian Brome was well established in a grassed area behind the Bristol United Press premises, Hawkins Street, St Philips, Bristol, G, ALG.

AVONMOUTH DOCKS. 1988 was a summer of anticlimax at the docks where the the most notable find was of a single plant of **Tribulus terrestris** L. on a quayside railway track. It was associated with **Amaranthus retroflexus** L., **Chenopodium glaucum** L., **Sida spinosa** L. and **Potentilla norvegica** L. Of the last species, J.W. White wrote 'An alien; one ..... that we are likely to have always with us' (Flora of Bristol, 1912, p.264), but recent records are strangely few. There is only one previous record of **Tribulus terrestris** in the Bristol area - from Portishead Dock (Miss Grignon) in 1931. The present record is documented in BSBI News No. 50 (Dec. 1988, p.30). This member of the Zygophyllaceae is known, because of its fruit, as Maltese Cross. It is a native of the Old World tropics but widespread as a weed in warm countries. However, it is a very rare British alien, probably introduced at Avonmouth in 1988 from animal foodstuffs.

Elsewhere in the docks the grass **Beckmannia syzigachne** (Steud.) Fernald has been decimated during excavations for new pipelines; a few plants survive, associated with **Scirpus maritimus** L. and **Ranunculus sceleratus** L. A single plant of **Trifolium glomeratum** L. was on sweepings from a mill handling N. American grain - an example of a European species introduced into USA and then re-exported to Europe! **Sida spinosa** L. was again common throughout the docks but other soya bean waste aliens such as **Amaranthus albus** L., **A. spinosus** L., **Anoda cristata** (L.) Schlectend. and **Ipomoea** spp. recorded in 1987 were confined to the immediate vicinity of the Charles E. Ford mill which handles this product. Seed collected from the area has been investigated by Mr C.G. Hanson: it is hoped that the findings will be discussed in 1989. All Avonmouth Docks records, G, ALG.

I thank everyone who has supplied records and helped with these, especially Mr P.J.M. Nethercott, Captain R.G.B. Roe and Mr A.L. Grenfell. I am indebted to Long Ashton Research Station for meteorological records.

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BRISTOL'S URBAN ECOLOGY

EDITED BY A.E. FREY
ASSISTED BY A COMMITTEE

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INTRODUCTION

The urban ecology of the Bristol region forms the second theme issue published by the Society and follows the successful first theme issue which featured the Avon Gorge.

It goes without saying that a vigorously expanding urban nexus of over half a million people is going to transform the environment over which it encroaches and comprehensively to alter the habitat for non-human species of wildlife. However it would be wrong to picture this growth just as a surging and uniform tide of buildings, because all cities legislate for a surprising amount of open space within the built-up area and for the retention of amenity habitat, a process in which this Society has been an active advocate for many years. Not only does the city retain much original habitat, but in their gardens many Bristolians recreate miniature environments which species colonise, sometimes under active encouragement, although it must be said that attitudes to wildlife species differ enormously within the human population, as is repeatedly revealed in the articles which follow.

Just as people differ, so too does wildlife, with some species totally unable to make any sort of accommodation to the urban condition. Urban encroachment is however, except for estate building in places like Bradley Stoke, often a gradual process, giving wildlife lots of opportunity to make small incremental adjustments to this gradual urban expansion. The result is that a few species become partially or even totally adapted to their human neighbours and his structures while, for the remainder, increasing encroachment will be tolerated until their particular threshold of interference is reached, at which point numbers decline rapidly. The various papers which follow set out these differences for a sample variety of species - foxes, badgers, bats, birds and a group that man chooses to call 'pests'. It will emerge that foxes and house sparrows, for example, have adapted to the city amazingly well, whereas some bird species like the skylark find man's presence intolerable. In between, the badger is revealed as hanging on through some formidable urbanisation changes, but may well now be close to, or even beyond, its tolerance threshold. Bats are an example of species which are widely adapted to man' structures and can be found throughout Avon, but cannot cope with intensive urbanisation. Sometimes coping is a matter of food supply, of suitable hides or roosts, of territory, but balanced against people's tolerance and encouragement of the species.

This volume also takes an older part of the city, Clifton, and builds up over time a picture of the great variety of building stones and materials that have gone to constitute the urban fabric, from where they were obtained and how they were influenced by changing fashions in architectural style. It is but a small step from understanding the geology of Clifton's buildings to understanding that for the wider city where natural materials have been used.

As I remarked in the Introduction to the Avon Gorge volume, ecological work goes on all the time and new findings will justify a return to this urban theme on a future occasion. For the present, these papers represent a good cross section of the varied relationships between man and the other occupants of his urban environment, a subject which must surely be of interest to all those who look beyond the self-interest of our own dominant and intrusive human species.

ALLAN E. FREY, **Hon. Editor**

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BRISTOL'S FOXES

by STEPHEN HARRIS & TOM WOOLLARD

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INTRODUCTION

Urban foxes (**Vulpes vulpes**) are widespread in Britain, being found in many cities in south and central England and parts of Scotland; they are rare in northern and eastern towns (Macdonald & Newdick, 1982; Harris & Rayner, 1986a). The timing of the colonisation of urban areas by foxes has been documented for London by Fitter (1945), Teagle (1967), Beames (1972) and Harris (1977). These authors showed that foxes were increasing in abundance in the Kent and Surrey suburbs in the 1940s and from there rapidly spread inwards, so that by 1975 foxes were breeding five kilometres from the city centre and occasional animals were recorded in the very centre of London.

Although comparable documentary evidence is lacking for Bristol, it is probable that the pattern of events was similar. Tetley (1940) reported that foxes occurred close to Bristol and that one had killed a barnacle goose in the Zoo, but detailed records during this period are rare. During a survey in north-west Bristol between October 1977 and September 1978 many residents reported that foxes had been common in the area for twenty-five years (S. Harris, unpubl. data). However naturalists only really became aware of the foxes in Bristol in the late 1960s. To find out how common they were, an urban fox rally was held on the Downs on February 5 1967; fourteen foxes were seen and two more were heard calling (Hurrell, 1967). This rally became an annual event for the next decade and, from the 1970s onwards, records of urban foxes have featured in the mammal reports published in the Proceedings of the Bristol Naturalists' Society.

In October 1977 a long-term study of Bristol foxes was started and this is still continuing. As a result, Bristol has one of the best-studied fox populations in the world. Also, they have featured in two BBC films, "Foxwatch" and "20th Century Fox"; since the latter has been broadcast in a large number of countries, Bristol's foxes are extremely well-known both in Britain and abroad. In this paper we will review some of this wealth of data on Bristol's foxes and try to understand some of the factors contributing to their success.

HOW MANY FOXES ARE THERE IN BRISTOL?

Counting elusive nocturnal animals such as foxes is not easy. Although the red fox is found throughout much of the northern hemisphere from Japan to Alaska and Canada, and has been introduced into Australia, there are few reliable population estimates. In urban areas the problems with counting foxes are exacerbated, since the large number of landowners means that access is often restricted. To overcome these problems, Harris (1981a) developed a two stage survey technique.

Foxes live in family groups, which consist of two or more adults that normally produce one litter of cubs each year. Foxes all breed at the same time of year (the mean week for births in Bristol is March 12-18), and the cubs come above ground when four weeks old. Therefore, searching for breeding earths in early May will provide a count of the number of fox litters (and hence families of foxes) in a particular area. Harris (1981a) did this for two consecutive years (1979 and 1980) in two areas, one of 5.5 km² which included parts of Stoke Bishop, Sneyd Park, Westbury-on-Trym, Sea Mills and Coombe Dingle and the other of 3.2 km² which covered parts of Cotham, Redland, Bishopston and Westbury Park. A letter was delivered to all the 19,000 households in the two areas requesting that sightings of fox cubs, or known breeding sites, be reported to the University. All these reports were investigated and all open areas and pieces of waste land were searched for cubs. Wherever possible, litters of cubs were ear-tagged and lactating vixens radio-collared so that their movements could be monitored. By this means, it was calculated that there were 20 fox family groups in the larger area and 10 in the smaller, a mean density of 3.64 and 3.13 fox family groups/km² respectively.

To estimate the number of foxes in the rest of Bristol, several techniques were tried until one was found to work. For this, all 247 schools in Bristol were asked to record fox sightings from May 6 to June 6, 1980. Detailed instructions and recording forms were sent to each class and 87% of the schools helped with the survey. From these schools, from members of the Bristol Naturalists' Society and from casual information supplied by the public, 4227 records were collected. These sightings were allocated to one of the 464 500-metre squares which cover the urban area of Bristol; the distribution of records was subsequently smoothed by ascribing to each square the mean of the total number of sightings for the block of nine squares for which it was the centre.

Then, for the two areas of Bristol that had already been surveyed for litters of cubs, the actual number of sightings per family of foxes was calculated, and this figure was used to calculate the distribution and total number of fox family groups in Bristol. This showed that there are 211 fox family groups in the whole city. This is a mean density of 1.82 fox family groups per km², although densities can rise locally to 5.0 fox family groups per km². The distribution of foxes in Bristol is shown in Figure 1. As can be seen, most are to be found in north Bristol, with centres of distribution in two areas either side of the M32 corridor.

Although this sounds like a simple survey technique, it is remarkably accurate. The original survey was undertaken in 1980 and, despite intensive field work in the succeding nine years and surveys of small areas to check the original estimates, there is no evidence to suggest that the figure of 211 fox family groups is wrong.

HABITAT REQUIREMENTS OF URBAN FOXES

From the results of the household survey in north-west Bristol and records collected by the Bristol Naturalists' Society, there is considerable evidence that foxes have been present in Bristol since at least the inter-war years. Foxes are no longer in the process of colonising the city, and there is no evidence for any increase in numbers since the survey in 1980; their distribution is still as shown in Figure 1. The obvious question is: why are they so rare in some areas? It is likely that some feature of the habitat must be limiting fox numbers.

To try to understand the habitat requirements of urban foxes, Harris & Rayner (1968b) used the data from fox surveys in seven English towns (Bath, Birmingham, Bristol, Dudley, Poole, Solihull and Wolverhampton). These surveys were all undertaken along the lines first developed in Bristol and mean fox densities were found to range from 0.19 (Wolverhampton) to 2.04 (Poole) fox family groups per km². By comparing fox densities with a wide variety of habitat parameters in all these cities, Harris & Rayner (1986b) found that foxes were most frequent in residential areas, particularly in areas of owner-occupied

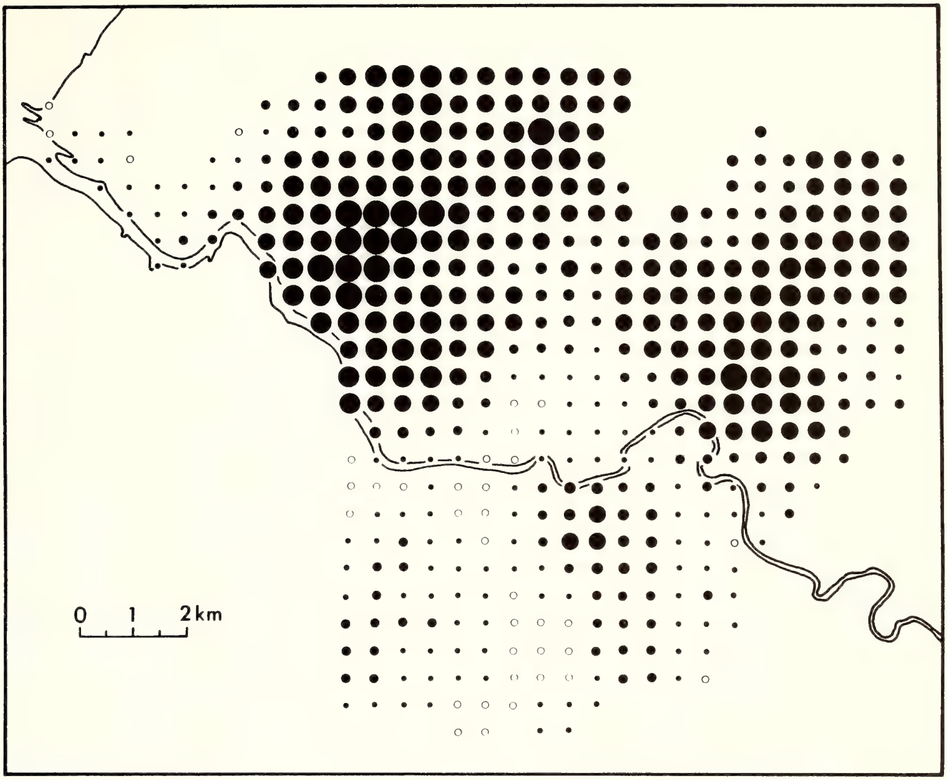

FIGURE 1 Fox distribution and density in Bristol in 1980. Each symbol denotes the density calculated for that particular 500 m square. Open symbols denote less than 0.5 fox family groups km^{-2}, and solid symbols with increasing size 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-3.0, 3.0-4.0 and 4.0-5.0 fox family groups km^{-2}. Figure from Harris (1981a).

housing where the housing density and the number of people per household were low. Foxes were less common in residential areas consisting of council-rented housing, industrial areas, city centres and in areas of high habitat diversity.

Harris & Rayner (1968a) and Harris (1986) used these findings to try to explain when and why foxes first colonised British cities. They showed that the habitat most preferred by foxes was the low-density 1930s housing; such properties were built when land was cheap and so gardens were reasonably large. In the period after 1930 there was a boom in private house construction and cities increased dramatically in size as these low-density suburbs expanded. In London, for instance, between 1918 and 1939 the human population grew by only 25%, but the size of the city grew threefold (Jackson, 1973). A similar pattern of change was occurring in many other British cities. Prior to the 1930s, low-density residential suburbs were rare and so most urban areas were generally less suitable for foxes. The habitat that proliferated in the 1930s was ideal for foxes and is still the preferred habitat today.

Whether foxes moved into the suburbs from the surrounding rural areas is unknown, but it is probable that during the inter-war years the piecemeal development of many cities engulfed tracts of rural land which were developed later, thereby gradually forcing the foxes to live in closer contact with man. Once established in these suburbs, which certainly occurred by the end of the Second World War, the foxes moved further into the city and colonized less favoured habitats. This hypothesis, which almost certainly applies to Bristol but for which there is little documented evidence, is supported by Teagle's (1967) detailed description of the course of events in London.

POPULATION DYNAMICS OF BRISTOL'S FOXES

We have shown that in Bristol there are 211 fox family groups, and that this number remains constant from one year to the next. However, the fox population must undergo seasonal variations in size, due to the patterns of birth, death, emigration and possibly immigration. Also, it would be valuable to be able to translate 211 fox family groups into actual numbers of foxes so as to be able to know how many foxes there are in Bristol, how long they live and what happens to all the cubs born each year.

To help in answering these questions, the cadavers of 1701 foxes killed in Bristol have been examined and details of causes of death for 1636 of these foxes are shown in Table 1. It is hard to be sure that these figures represent the true

	ADULTS (animals six months or older)		CUBS (animals < six months old)	
Cause of death	Males n=473	Females n=303	Males n=431	Females n=429
Road accidents	60.2	63.1	62.7	65.8
Shot	5.8	3.1	0.4	0.4
Snared	3.9	4.3	1.6	0.9
Trapped	2.7	2.4	-	-
Dug out	2.1	3.7	7.4	5.3
Killed by lurchers	3.8	3.1	1.2	0.4
Disease	8.9	11.2	5.9	7.9
Deserted cubs	-	-	1.2	2.7
Fights	3.3	2.2	7.1	9.2
Parturition	-	0.4	-	-
Trains	1.4	0.8	-	0.4
Misadventure	1.4	1.6	3.9	3.5
Unknown	6.5	4.1	8.6	3.5

TABLE 1 Causes of death for 1636 foxes collected in Bristol; the figures are percentages. Data from Harris & Smith (1987).

importance of each cause of death since, for example, foxes that die of disease may remain underground, so that their corpses are less likely to be recovered. However, there is a very good network of contacts in the Police, RSPCA, local authorities, veterinary surgeons, etc. that report dead, diseased or dying foxes, and it is probable that the sample in Table 1 is reasonably unbiased. The one exception to this is the category for deserted cubs; there is a high degree of cub mortality prior to emergence above ground and these animals are poorly represented in the sample.

From the cadavers a variety of data were recorded. In particular the adult foxes were aged by counting annual growth rings in the premolar teeth of the lower jaw (Harris, 1978), and for vixens the reproductive tract was examined and the position and number of any placental scars recorded. Evenly spaced, darkly stained sets of scars were taken to indicate that a litter of cubs had been produced that year.

From these data Harris & Smith (1987) calculated that the mean life expectancy for male foxes in Bristol is 16.6 months, for females 17.8 months. The annual rate of mortality for male foxes less than a year old is 57%, for female foxes less than a year old 54%. For animals over a year old annual mortality rates are slightly lower; 50% for both males and females. Of 1628 animals for which ages were established, only one had reached nine years of age.

Harris & Smith (1987) also used these post-mortem data to find out exactly how many foxes are present in Bristol. The survey undertaken by Harris (1981a), and described above, showed that there are 211 fox family groups and that each year about 10% of these family groups fail to produce a litter of cubs. Hence each year there are about 190 breeding vixens. From the post-mortem data Harris and Smith found that in addition to the 190 breeding vixens there are 68 vixens that fail to breed and another 75 that become pregnant but fail to produce a litter of cubs. Hence the total population of adult vixens in Bristol in the spring is 333. They also showed that the sex ratio of the adult population is 0.81 females per male, i.e. the adult male population is 383, giving a total adult fox population of 716 animals. From the post-mortem data, the mean litter size was found to be 4.72, so that the 190 breeding vixens produce 897 cubs (496 males, 401 females). Most births occur in March, so the total fox population in Bristol at the beginning of April each year is 716 adults and 897 cubs, or an average of 3.39 adults and 4. 25 cubs per family group.

Since Harris & Smith (1987) were able to examine a large number of foxes, they were able to calculate the monthly mortality rates, and these are shown in Table 2. As can be seen, the population is largely self-sustaining, with a low level of net emigration (the difference between the number of foxes that move into the city and those that move out).

DISPERSAL OF BRISTOL'S FOXES

Since Bristol's fox population has reached a stable level and is producing approximately 900 cubs a year, what happens to them all? We have shown above that mortality is high and that over half the cubs fail to survive to one year old. However, mortality is only one means of population regulation; dispersal is another. Fox cubs grow rapidly; they reach adult size by the end of September and, in the autumn or winter, some disperse from their natal home range to a new area. To study the dispersal behaviour of Bristol's foxes, 1387 were marked with numbered white plastic ear tags between October 1977 and October 1986. These animals were dug out of their natal earths, trapped or occasionally netted or snared. Information on their movements was obtained from animals recovered dead, those

		Foxes over one year old	Foxes less than one year old
Population on April 1 each year		716	897
Population at end of:	April	689	779
	May	656	738
	June	636	693
	July	618	656
	August	604	623
	September	578	593
	October	550	552
	November	516	516
	December	489	473
	January	422	426
	February	382	363
	March	353	390
		716	
Net emigration during the year		6	32

TABLE 2 Monthly changes in the size of the fox population in Bristol. Data from Harris & Smith (1987).

re-trapped, or from animals that came into gardens to be fed or were seen in similar situations where the number on the tag could be read. Details of the number of animals caught and the sources of the movement records, are given in Table 3.

This tagging study showed that only 73% of male cubs and 32% of female cubs disperse; the rest remain on their natal range (Harris & Trewhella, 1988). Occasionally adult foxes disperse, but this is uncommon. Most dispersal distances are short, with a mean of 3.1 km for males and 1.8 km for females, although occasionally much longer movements do occur. Two male cubs marked in south Bristol were killed 18 kilometres away on the Mendips near the upper end of Cheddar Gorge and one tagged fox was killed at Woolverton, near Rode. Its tags, however, were not returned and so it was not possible to calculate its dispersal distance, although it must have been at least 24 kilometres. Dispersal has a consequence on life expectancy; male foxes that disperse live only 85% as long as those that do not, and those that disperse furthest live the shortest time.

The tagging study also showed that, of the animals marked as cubs in Bristol, 14% of those recovered when more than six months old had moved out of the city (Trewhella & Harris, 1988). So far there is little evidence of immigration into the city and the data in Table 2 show that the low level of emigration produces a stable population without any need for immigration. Clearly the fox population in Bristol is self-sustaining and in fact produces a slight excess number of cubs each year.

Of the foxes that do disperse out of the city, many move to the south, and

	MALES				FEMALES			
	Number caught	Number recovered dead	Number retrapped	Number sighted	Number caught	Number recovered dead	Number retrapped	Number sighted
Cubs (less than six months old)	586	238	63	5	498	196	115	8
Sub-adults (six to twelve months old)	36	14	7	1	38	15	4	1
Adults (over twelve months old)	88	45	12	3	141	56	35	8
Totals	**710**	**297**	**82**	**9**	**677**	**267**	**154**	**17**

TABLE 3 Number of animals caught and tagged between October 1977 and October 1986, and the sources of their movement records. Data from Harris & Trewhella (1988).

recoveries in the area around Long Ashton, Abbots Leigh and Portbury are most common. To reach here, the foxes probably swim the River Avon and Harris (1986) has radio-tracked foxes that repeatedly swam the river in search of a new home range, even when the river was in full spate.

BEHAVIOUR OF BRISTOL'S FOXES

To study the behaviour of the foxes in Bristol, 45 animals (25 males, 20 females) were fitted with radio-collars. Radio-tracking was done on foot, one animal being followed throughout the night and its position and activity recorded every five minutes. By this means it was possible to collect a great deal of information on the behaviour of each animal, and the foxes very quickly became used to being tracked. They appeared to be totally unconcerned by being followed, and sometimes would even come right up to the person who was studying them.

The normal monthly home range size for a fox living in an area with a high density of foxes is about 50 hectares and there is a high degree of overlap in the ranges of neighbouring family groups, although the degree of contact between adjacent family group members is not known. However, monthly ranges can be as small as fifteen hectares or, in lower density areas, up to or even over 100 ha. The whole range is not used to the same degree; within its home range a fox will have a number of different day-time lying up sites and two or three core areas of activity. These may be areas of high food availability or of lessened disturbance. These core areas are very small and constitute only 8-10% of the total home range; roughly 60% of all the radio fixes collected for a fox in any month will fall in an area of only four hectares. So, not only is the home range relatively small, but a fox spends most of its time in a small part of that range.

From the radio-tracking data it was possible to recognise three types of behaviour. These were: (i) inactive, when the animal was either resting or asleep;

(ii) active but moving less than 100 metres in five minutes, usually when foraging and (iii) active and moving more than 100 metres in five minutes, usually when moving from one part of the range to another and hence not foraging. Each night a fox would spend 10-15% of its time moving fast from one part of the range to another, 35-50% slow moving or foraging and 35-50% resting. Foraging occurs throughout the night, but with more after midnight than before. Most fast movements occur between 0300 and 0500 hrs GMT. Periods of inactivity range from 5 to 240 minutes, with an average of about 50 minutes, and occur throughout the night.

The pattern of activity is probably highly influenced by traffic and other human disturbances. Hence foxes living near the city centre may not become active until midnight, and road deaths are more frequent on Friday and Saturday nights, when there is more late-night traffic. Weather conditions also have an important influence on behaviour; strong winds tend to make foxes very wary, while cold, driving rain keeps them under cover. However, warm, wet nights with little wind are favoured by foxes and on such nights it is easy to see several animals hunting earthworms on the Downs or on one of the many playing fields in Bristol.

FOOD OF BRISTOL'S FOXES

The ability of foxes to exploit a diversity of food sources is a significant factor contributing to their success and, in particular, to their ability to colonise a wide variety of habitats, including urban areas. To see what the foxes in Bristol eat, the stomach contents of 986 foxes killed in Bristol were examined. The technique was exactly the same as that used by Harris (1981b) to study the food of foxes in London. The contents of each stomach were washed through a sieve of mesh size 710 microns, and flooded with water. The abundance of each item was scored on a scale of one to five as described by Harris (1981b), so that a measure of the relative proportions of the various items was obtained. A summary of the diet of Bristol's foxes, and a comparison with the results from London, is shown in Table 4.

The pattern of monthly changes in the diet of both adults and cubs in Bristol (Figures 2 & 3) is very similar to that described by Harris (1981b) for foxes in London, with birds (mainly passerines) particularly important in the spring diet of cubs and adults and with feral pigeons more abundant in the winter diet of adults. Insects are particularly important in the summer diet of cubs and fruit and vegetables are most frequent in the late summer and autumn. Not only are the seasonal patterns of the diets very similar, but the actual species composition and proportions within the broad heads shown in Table 4 are also remarkably uniform in both cities.

The major difference between the diet of London and Bristol foxes is the importance of scavenged food in the diet of Bristol foxes. In London, scavenged food forms 35% of the diet of adult foxes, 20% of that of cubs, whereas for Bristol the figures are 50% and 36% respectively. In this context the term "scavenged" is probably misleading, since it implies that the food items were obtained by stealth or deception. In fact most of the food included in this category was undoubtedly put out for the foxes or taken from bird tables; some extreme examples of the degree of human largesse are given in Harris (1986).

The question is: why is there less scavenged food in the diet of London's foxes? It is unlikely that the foxes in London are provided with less food by the human population, since most of the food specifically put out for foxes is in the form of meat, fat and bones, and this category is relatively unchanged between

	LONDON		BRISTOL	
	Adults (animals six months or older) n=313	Cubs (animals less than six months old) n=258	Adults (animals six months or older) n=642	Cubs (animals less than six months old) n=344
Earthworms	12.2	11.1	6.5	9.2
Pet mammals	2.9	4.2	0.6	0.7
Wild mammals	13.1	10.0	4.5	3.5
Pet birds	5.8	3.4	1.8	0.8
Wild birds	14.4	27.5	6.5	11.5
Insects	9.2	15.4	16.3	26.9
Fruit and vegetables	7.6	8.2	13.6	11.2
Scavenged meat, bones and fat	24.1	13.8	26.6	19.2
Other scavenged items	10.7	6.4	23.6	17.0

TABLE 4 Relative importance of the various food items in the diet of foxes in London (data from Harris, 1981b) and Bristol. The figures are percentage of the diet by volume.

London and Bristol. The main difference is in the items contained in the "other scavenged items" category. This includes bread, nuts and birdseed, which would be obtained from bird tables and, to a lesser extent, potato and other peel that would be gleaned from compost heaps. Why there should be more food available to Bristol foxes from bird tables and compost heaps is at present unclear.

The other main differences between London and Bristol are the increased importance of insects, fruit and vegetables in the diet of Bristol's foxes, and the marked reduction in the level of predation on wild and pet mammals and birds. Again at present we do not know exactly why there should be these differences in the diets of the two urban fox populations.

DAMAGE CAUSED BY BRISTOL'S FOXES

To estimate how much damage is caused by foxes in Bristol, 5480 households in an area of 5.5 km^2 were visited and questioned on losses to foxes. A total of 5191 (94.7%) of the households agreed to complete the questionnaire. Fox population density in that area was high; 3.64 fox family groups per km^2.

In the 5.5 km^2 area there were 1225 pet cats; eight households (0.7%) had lost a cat to a fox within a year of the survey, and 25 (2.0%) had lost a cat more than a year before the survey. Only cases where it was certain or highly probable that foxes had taken the cat were included in the survey and most of these cases related to cats less than six months old. In addition, 262 households (5.1%) kept other than cats or dogs in the garden (rabbits, guinea-pigs, chickens, ducks, gerbils, tortoises, pigeons and/or hamsters), in a situation where foxes could reach and kill them. Of these 262 households, 21 (8.0%) had suffered a loss

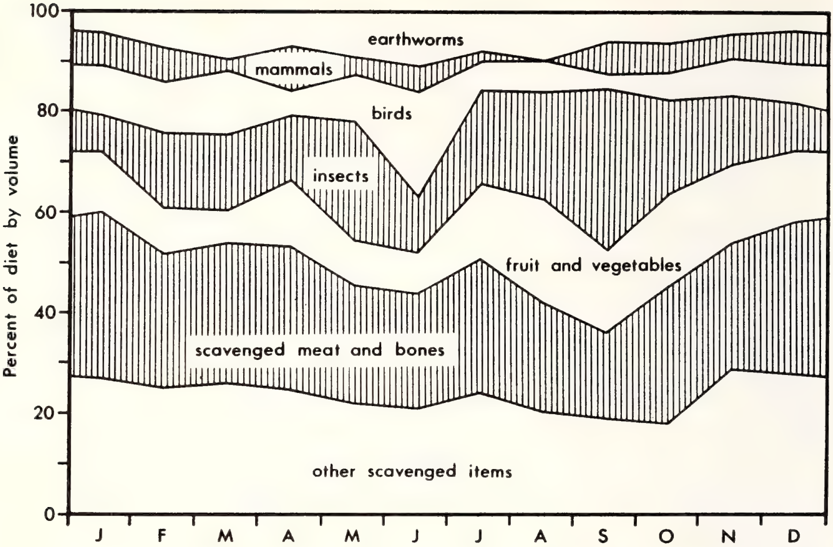

FIGURE 2 Monthly variation in the stomach contents of Bristol foxes over six months old, excluding all non-food items. The categories "mammals" and "birds" include both wild and domestic species. Based on the analysis of the contents of 642 stomachs.

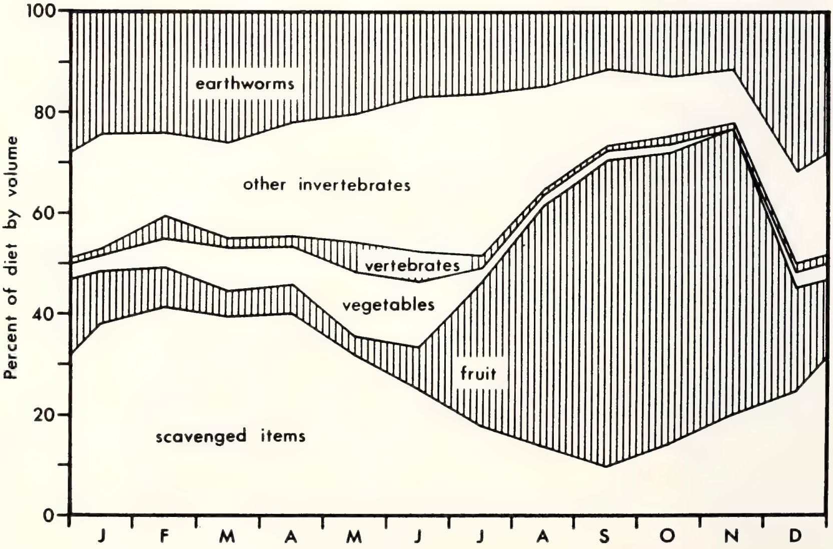

FIGURE 3 Monthly variations in the stomach contents of Bristol foxes less than six months old, excluding all non-food items. The categories "mammals" and "birds" include both wild and domestic species. Based on the analysis of the contents of 344 stomachs.

within one year, and 134 (51.1%) had lost such pets to foxes more than a year prior to the survey (Table 5). A further six households had evidence of foxes taking goldfish from their ponds and one of foxes taking frogs. However, these losses cannot be quantified since the number of households that kept goldfish and other pond animals was not surveyed.

	Losses incurred within a year of the survey	Losses incurred more than a year before the survey	Unsuccessful attack on pets attributed to foxes	Buried animals dug up and eaten by foxes
Rabbits	13	58	10	4
Guinea-pigs	7	44	2	2
Cats	8	25	53	4
Chickens	-	22	2	1
Goldfish in ponds	-	6	-	-
Ducks	-	4	-	-
Gerbils	-	2	-	-
Tortoises	-	2	3	-
Pigeons	1	1	-	-
Hamsters	-	1	-	-
Frogs	-	1	-	-
Dogs	-	-	1	2
Foxes	-	-	-	1

TABLE 5 Number of households in north-west Bristol that lost pets to foxes, based on 5191 completed questionnaires. The figures show the number of households that suffered a loss, but more than one animal could be lost in a single incident. The survey area contained 1225 pet cats; 262 (5.05%) of the households questioned kept one or more other pets (rabbits, guinea-pigs, ducks, chickens, gerbils, tortoises, pigeons and/or hamsters) in the garden in a position where foxes could kill them. Data from Harris (1981b).

Enquiries concerning other forms of damage or nuisance are summarised in Table 6. Damage to garden crops was rare. Also, only 2.7% of households reported that foxes frequently rifled dustbins, 16.4% occasionally and 80.9% never suffered this nuisance. Even these figures may be an overestimate, since most households assumed that foxes were the culprits and not cats, dogs or badgers, which also rifle dustbins.

These results show that even in an area of high fox density the damage they cause, or nuisance value to the local residents, is very small. Most people questioned agreed that the foxes caused them little real nuisance and even some of the people who had lost pets to foxes said it was their own fault for having kept their pets in an inadequate cage.

		No.	%
Tipping out dustbins:	frequently	138	2.7
	occasionally	853	16.4
	never	4200	80.9
Eating fruit and vegetables:	cabbages	9	-
	marrows	2	-
	leeks	2	-
	bulbs	2	-
	potatoes	2	-
	gooseberries	2	-
	loganberries	1	-
	broad beans	1	-
	peas	1	-

TABLE 6 Number of households suffering damage or nuisance - other than loss of pets - attributable to foxes. Based on 5191 completed questionnaires. Data from Harris (1981b).

CONCLUSION

In this paper we have managed to review only a few aspects of urban fox ecology that have been studied in Bristol since 1977. However, from the summary presented here it is clear that foxes in Bristol probably started to colonise the city nearly fifty years ago; they have reached a stable population level, and are undoubtedly a permanent feature of the urban ecosystem. They are highly adaptable, can respond rapidly to a changing environment and are a very successful urban species. Their future in Bristol is assured. This is in direct contrast to the badgers in Bristol, which are discussed in the next contribution by Harris & Cresswell (1989).

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BRISTOL'S BADGERS

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INTRODUCTION

In the preceding paper, Harris & Woollard (1989) described the fox population in Bristol and showed that they were a very successful immigrant species that probably started to colonise the city during the late 1930s and early 1940s. In this paper we will look at the badger (**Meles meles**) population in Bristol and compare it with the fox population.

Much less is known about the ecology of urban badgers and the only other city that has been surveyed in detail is London, where Teagle (1969) found that badgers were still present in Richmond Park and Wimbledon Common and in nearby parks, golf courses and other private property. Virtually all the other records in Teagles's survey were from the semi-rural and rural fringes of the conurbation. There have been only sporadic reports of badgers in other cities (Neal, 1977) and, until recently, information on urban badgers was sparse. However, as a result of a long-term study of the badgers in Bristol which started in October 1977, much more is now known about the behaviour and ecology of urban badgers and Bristol's badger population has become one of the most comprehensively studied in Britain.

HOW MANY BRITISH CITIES HAVE URBAN BADGER POPULATIONS?

To see how widespread urban badgers were in Britain, Harris (1984) sent a questionnaire to all the Chief Environmental Health Officers of the District Councils in England and Wales and compiled information from local naturalists, museums and the local badger recorders appointed by the Mammal Society. Many small towns and villages have badgers living on their fringes or coming in at night from the surrounding rural areas to forage. However, since the aim was to establish how many urban areas had permanently resident badger populations, only towns and cities with a human population of at least 20,000 were included in the survey. Harris (1984) found that very few urban areas had established badger populations; those which did were mainly in South Essex, the south coast, parts of London, Edinburgh and some of the towns around London. In most of these only a few setts, usually less than a dozen, were present and they were largely confined to the urban fringes, railway lines, pieces of waste land, or the grounds of hospitals or similar institutions.

The four urban areas in which badgers were thought to be most numerous were parts of south-west London, Bristol, Bath and South Benfleet in Essex. The situation in London has already been described; in Bath, Harris (1984) reported several setts in gardens in the north-west and Smith (1982) described a study on a sett dug on a piece of undeveloped land in the south-east of the city; she also included records from elsewhere in Bath. Cowlin (1972) believed that sett density in South Benfleet and in other parts of the Southend-on-Sea conurbation was the highest in Essex. However, from his initial enquiries, Harris (1984) concluded that Bristol probably contained more badger setts than any other city in Britain.

HOW MANY BADGER SETTS ARE THERE IN BRISTOL?

To see exactly how many badgers setts there were in Bristol, Harris (1984) undertook a detailed survey of the city between October 1981 and April 1982. The survey area covered approximately 130 km^2 and included the city of Bristol itself, the suburbs of Kingswood and Filton, Avonmouth Docks and the parkland and factory estates adjacent to the city. All open spaces such as parks, playing fields, railway embankments, dock areas, waste land, hospital grounds, rubbish tips, golf courses, cemeteries and some factory sites were searched for badger setts, or signs of badger activity such as runs, latrines, digging for food, or hairs on fences. A total of 59 km^2 was covered in this way.

Also, in two areas of Bristol, badgers were known to frequent gardens regularly and in these areas all the households were sent a letter requesting information on badger activity in their gardens. Both areas were 6.3 km^2 in size; one was in north-west Bristol (Sneyd Park, Stoke Bishop, Sea Mills, Coombe Dingle and Westbury-on-Trym and the other was in north-east Bristol (Eastville, Stapleton, Fishponds and Frenchay). The combination of an extensive survey, plus

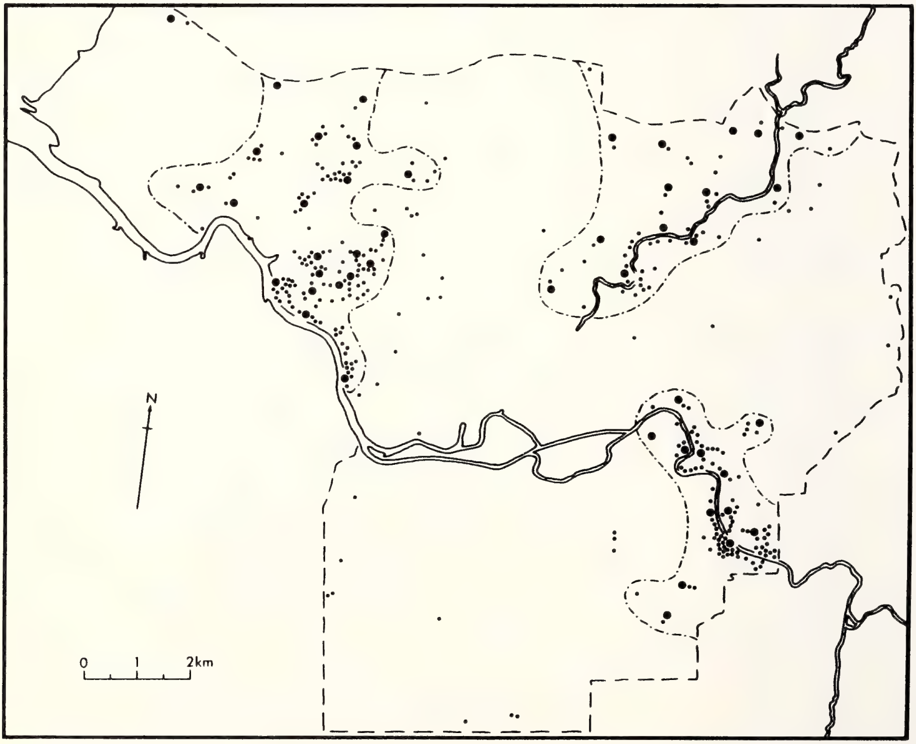

FIGURE 1 Distribution of badgers in Bristol in the winter 1981-1982, showing main setts (large dots) and other setts (small dots). Each main sett represents one social group, although not all the main setts were active at the time of the survey. The dot-dash lines mark the limits of the three populations referred to in the text and the broken line the boundary of the survey area. Redrawn from Harris (1984).

approaches to all the households in areas where badgers frequented gardens, gave a very thorough coverage of the city and, whilst not every small sett would have been found, it is unlikely that any large setts or established groups of badgers were missed. By this means a total of 346 badger setts were found in Bristol and these ranged in size from one to 37 holes, although not all these holes were in use at the time of the survey. Of the 346 setts, 308 were located in three distinct populations (Figure 1). The remainder were all small scattered setts and most appeared to have been relatively recently excavated.

	AREA OF THE CITY				TOTALS
	NW	NE	SE	Rest	
Total No. of social groups including inactive ones	21	13	12	-	46
Total No. of active social groups	17	10	10	-	37
Total No. of adult badgers	51	30	30	33	144
Total No. of badger cubs	34	20	20	-*	74
Total No. of badgers	85	50	50	33	218

* It was assumed that the itinerant badgers did not breed.

TABLE 1 Estimates of the numbers of badgers in Bristol in 1982. The methodology is described in the text.

HOW MANY BADGERS ARE THERE IN BRISTOL?

Badgers live in complex social groups and each social group has one main sett plus several other smaller setts (Kruuk, 1978). Therefore, by identifying all the main setts, it was possible to count the number of badger social groups in Bristol and the results are shown in Table 1.

In 1982, the year of the survey, the average size of the active social groups in the north-west population (which had been studied in detail - see below) was three adults plus two cubs and, by applying this figure to all the social groups that were active in Bristol in 1982, the total number of badgers in each population was calculated (Table 1). Estimating the number of itinerant badgers using the setts outside the main populations was difficult since small setts were often opened up by only one animal. Therefore, using a figure of one badger per small active sett outside the main populations, or two per larger sett, gave an estimated number of 33 itinerant badgers, or a total population of 218 badgers in Bristol in 1982. However, since there has been a steady decline from 1981 onwards in the number of badgers in the north-west population (see below), it is likely that the number of badgers in the rest of Bristol has also declined and is much lower today.

HABITAT SELECTION BY BRISTOL'S BADGERS

In each of the three main populations the badgers were selecting particular habitats in which to build their setts so that their present distribution probably reflects their distribution (but not their numbers) prior to urbanisation, since most of the areas in which they were rare or absent in 1982 consist of geological deposits which generally are unsuitable for digging setts (Neal, 1972). The following summary is based on Harris (1984):-

1. **The North-west Population** (Blaise Castle Estate, Coombe Dingle, Henbury, Sea Mills, Shirehampton, Sneyd Park, Stoke Bishop and Westbury-on-Trym).

Within this zone there were three principal habitats: the northern setts were located in the series of wooded parks around Blaise Castle, whereas in the central part they were in private gardens or on small pieces of undeveloped land while in the south they were on the sides of the Avon Gorge and around the Downs. In the central area most setts were associated with the Dolomitic Conglomerate outcrop and the small outcrop of Old Red Sandstone. In the Blaise Castle area the setts were clustered on the well-wooded rocky limestone slopes. Around the Avon Gorge the setts were located on the Carboniferous Limestone, where the coombes and gorges leading down to the Portway afforded dry slopes with outcrops of soft sandstone or earthy beds, alternating with harder masses of limestone which may have served as "roof rocks" under which the badgers could excavate.

2. **The North-east Population** (Eastville, Fishponds, Frenchay, Purdown, Stapleton, and Stoke Park).

Here the setts were located mainly in the valley of the River Frome, part of a wedge of Green Belt running in towards the city centre and which consists of a series of wooded parks or wooded banks preserved in the grounds of hospitals, or else they were located on the higher land to the north-west of the river. This latter area contains Stoke Park Hospital and its extensive grounds, a series of playing fields, and some small-holdings and market gardens. The gorge of the River Frome provides wooded slopes with access to the Pennant Sandstone, a rather hard sandstone, but markedly current-bedded so that the upper layers break up into a rubble. It was also extensively quarried in the past, giving easy access to inter-bedding planes and to open vertical joints which occur quite frequently. To the north-west of the River Frome the setts were on the Keuper Sandstone, a much softer sandstone, and these badgers may have been the remnants of a formerly larger population which was reduced when these easily cultivated sites were taken over by market gardens in the last century.

3. **The South-east Population** (Brislington, Broom Hill, Conham, Crew's Hole, Hanham Green, Jeffries Hill, Magpie Bottom, St. Anne's Park and Stockwood).

The situation here is similar in many ways to the north-east, the River Avon having cut an impressive gorge through the Pennant Sandstone. The natural rocky bluffs have been greatly extended by extensive quarrying on both sides of the valley and by the cutting of the main London to Bristol railway line. This activity not only left many rock faces but also large heaps of rubbly spoil. Again the situation offered wooded strips on dry sites with plenty of opportunity for relatively easy excavation of setts. Some of the area is currently managed as a semi-natural park, while the rest remains as waste land and factory estates. In many parts of the valley, particularly at Broom Hill, Conham, Hanham Green, Jeffries Hill, Magpie Bottom and St. Anne's Park, housing developments have encroached far into the river valley and here setts were found either in the gardens themselves, or the badgers entered the gardens to forage or to be fed.

	AREA OF THE CITY				
HABITAT	NW	NE	SE	Rest	Total No. of setts
Wooded banks, woodland	69	19	52	3	143
Waste land, scrub, disused gardens	20	17	18	10	65
Gardens	29	3	1	9	42
Fields, sports grounds, paddocks	7	5	4	5	21
Rubbish tips	1	2	9	1	13
Golf courses	10	-	1	-	11
Disused quarries	4	-	7	-	11
Under sheds, buildings	3	1	4	3	11
Allotments	1	1	-	4	6
Hedgerows	-	6	-	-	6
Factory sites	-	-	4	-	4
Under walls	2	1	1	-	4
Railway banks	-	-	-	3	3
School grounds	2	-	-	-	2
Old drains	2	-	-	-	2
Ditches	-	1	-	-	1
Cemeteries	-	1	-	-	1
Totals	**150**	**57**	**101**	**38**	**346**

TABLE 2 Habitats from which the 346 badger setts in Bristol were recorded. Data from Harris (1984).

Away from these three populations, most of the setts were small and used only sporadically. The habitats in which the setts in different parts of the city were found are shown in Table 2. It seems probable that most of the larger badger setts in Bristol were relicts that had been enclosed during urban development. This was certainly true for the north-eastern and south-eastern populations where the majority of setts survived on land left as parkland or wasteland, although some setts were found in private gardens and on factory sites. In the north-west population, the setts around the Blaise Castle and Avon Gorge/Clifton Down areas were also relicts that survived urban encroachment. However, in the central area around Stoke Bishop and Sneyd Park, the badger population was more equivocal in its origins. Some setts were very large, dug on wooded banks, and had obviously survived development, the majority of which was undertaken in the period just after the First World War (Morgan, 1977). However, here the badgers were also expanding into the urban area. Some setts were not dug until the 1970s and, in two cases, these new setts formed the main sett of the social group. Another sett, dug under a summerhouse in 1980, was used for breeding in 1982.

ACTIVITY LEVELS IN THE THREE BADGER POPULATIONS

For each sett that was located, every hole was counted and scored as well-used, partially used or disused, this providing a measure of badger activity at that sett. For this analysis, the north-west population was divided into three (Table 3). In Sneyd Park, Stoke Bishop and part of the Coombe Dingle districts the setts were in gardens or on steep wooded banks of difficult access. Here there was little evidence of human disturbance; only 12% of the setts were completely inactive when visited and 35% of the holes were disused. In the area

	WELL-USED HOLES		**PARTIALLY-USED HOLES**		**DISUSED HOLES**		**SETTS COMPLETELY DISUSED WHEN VISITED**	
	No.	%	No.	%	No.	%	No. disused/ Total No. setts	%
North-west								
Stoke Bishop, Sneyd Park, Coombe Dingle	127	42.6	66	22.2	105	35.2	9/78	12
Avon Gorge, Clifton Downs	16	30.8	10	19.2	26	50.0	6/16	38
Shirehampton, Blaise Castle estate	38	12.2	76	24.3	198	63.5	29/56	52
North-east	117	29.9	139	35.6	135	34.5	5/57	9
South-east	190	55.6	49	14.3	103	30.1	13/101	13

TABLE 3 Levels of sett usage recorded in the three main badger populations in Bristol. Data from Harris (1984).

around the Avon Gorge and Clifton Downs, some setts were easily accessible and suffered disturbance in the form of repeated blocking of holes or of pet dogs exploring the tunnel systems. Of the setts in this area, 38% were completely inactive and 50% of the holes disused. In the Blaise Castle and Shirehampton areas, all of the setts were of easy access and badger digging, snaring (mainly for foxes) and the use of lurchers to catch badgers 'worming' on fields at night were frequent; 52% of the setts were completely inactive when visited and 64% of the holes were disused. In the north-east population there was some digging, snaring and use of lurchers, but this was largely confined to Purdown and Stoke Park; 9% of the setts were completely inactive when visited and 35% of the holes disused. However, only 30% of the holes were classified as well-used. In the south-east population, where there was least evidence of digging, snaring or use of lurchers, 56% of the holes were well-used, while the figures for disused holes (30%) and completely inactive setts (13%) were comparable with those from the north-east.

Clearly the ease of access of badger setts in Bristol, and the level of disturbance they experience, are major factors affecting the success and survival of badgers within the city. Also, it is important to remember that this survey was undertaken in the winter of 1981/82. Since then, the area in south-east Bristol, which contained the least-disturbed badger population, has had increased public access and this may well have had an effect on the badgers. In the north-west of Bristol where land prices are currently very high, many pieces of waste land containing setts have been cleared and developed and other setts, including two of the key breeding setts, have been threatened by development. Clearly a re-survey to access any changes in the status of the Bristol population will soon be needed.

BEHAVIOUR OF THE BADGERS IN NORTH-WEST BRISTOL

A detailed study of fifteen social groups of badgers in north-west Bristol was begun in 1978. Each year badgers were caught in cage traps baited with peanuts, occasionally in snares, or with hand-held nets while they were foraging at night in open spaces (Cheeseman & Mallinson, 1980). All animals caught were marked with a tattoo on each side of the inguinal area and ear-tagged (Cheeseman & Harris, 1982). Selected animals were also fitted with radio collars. This long-term study has enabled us to undertake a detailed analysis of the behaviour and population dynamics of the Bristol badger population.

Badgers were radio-tracked on foot and followed continuously from their time of emergence until their return to the sett at dawn. In this way some 69 badgers (35 males, 34 females) were radio-tracked for a total of 606 nights. Compared to rural badgers, the time of emergence of urban badgers was on average an hour to an hour and a half later (Harris, 1982). Weather also had a significant effecton the behaviour of urban badgers. Bright moonlight and the absence of cloud cover, for instance, both delayed emergence and, once the badgers had emerged, they travelled less far and more slowly on such nights (Cresswell & Harris, 1988a). Once again the badgers were active, they spent the night interspersing periods of activity with periods of sleep; these rest periods were spent underground in a sett, or the badgers lay up above in a flower bed or even in the middle of a lawn. Sometimes they built nests from piles of dry leaves or bundles of hay under garden bushes.

It was possible to calculate the size of the range of the social groups by radio-tracking several animals from each group (Table 4). From this, it can be seen that group ranges were largest in the spring, during the mating season, and

SPRING (Mar-May) n=8	**SUMMER** (Jun-Aug) n=6	**AUTUMN** (Sep-Nov) n=9	**WINTER** (Dec-Feb) n=9
50.8 ± 10.1	30.1 ± 13.8	33.9 ± 4.2	10.3 ± 5.1

TABLE 4 Average social group range size for badgers in north-west Bristol for each quarter of the year; values are in hectares ± S.E. Data from Cresswell & Harris (1988b).

smallest in the winter. Not only were the ranges smallest in winter, but the total time the badgers were active was markedly reduced. Although the group ranges were largest in the spring, badgers were active for the longest period of time and travelled the greatest distances during the summer (June to August). It was at this time of year that the greatest diversity of food types was eaten, because there was no single particularly profitable source of food, and hence the badgers had to spend more time looking for scattered sources of food.

CHANGES IN THE NUMBERS OF BADGERS IN NORTH-WEST BRISTOL

From the long-term trapping programme in north-west Bristol, it was possible to calculate the total number of badgers in the area. Nearly all the badgers were marked and each year most of the new animals caught were cubs or yearlings that had been missed the previous year. There appeared to be little immigration of animals into the area.

The population changes for the years 1979 to 1985 are shown in Figure 2. The total number of badgers varied between 80 in 1981 and 47 in 1986, and there was a steady decline in numbers from 1981 onwards (Harris & Cresswell, 1987). Calculations of survival rates showed that 64% of badgers died within their first year and that there was little difference in the mortality rates of males and females in the first two years of life. However, from three years of age and older, the mortality rate of males was considerably higher and, although the sex ratio of cubs born was 50:50, the adult badger population was biased towards females.

Why the population should have been subjected to a steady decline in numbers since 1981 is unknown. Although some setts have been threatened in 1987 and 1988, sett losses during the period 1981 to 1986 were insignificant, and did not involve any main setts. These changes may be part of a natural long-term fluctuation in numbers, and it is known that numbers have been low on previous occasions. For instance, during 1968 to 1971 many of the setts around the University Halls of Residence in Stoke Bishop were disused or only rarely visited by badgers, but all were very active at the commencement of the study in 1977 (S. Harris, unpubl. data). However, since the present decline in numbers has been continuous from 1981 to 1988, and several main setts are now being threatened by developers, the long-term outlook for the population is uncertain.

DISPERSAL OF BRISTOL'S BADGERS

We have already said that immigration into the badger population in north-west Bristol is comparatively rare. To study the movements of animals both within and out of the population, 211 badgers (93 adults, 118 cubs) were marked between 1978 and 1985. Recovery of these animals as road deaths, or their subsequent re-

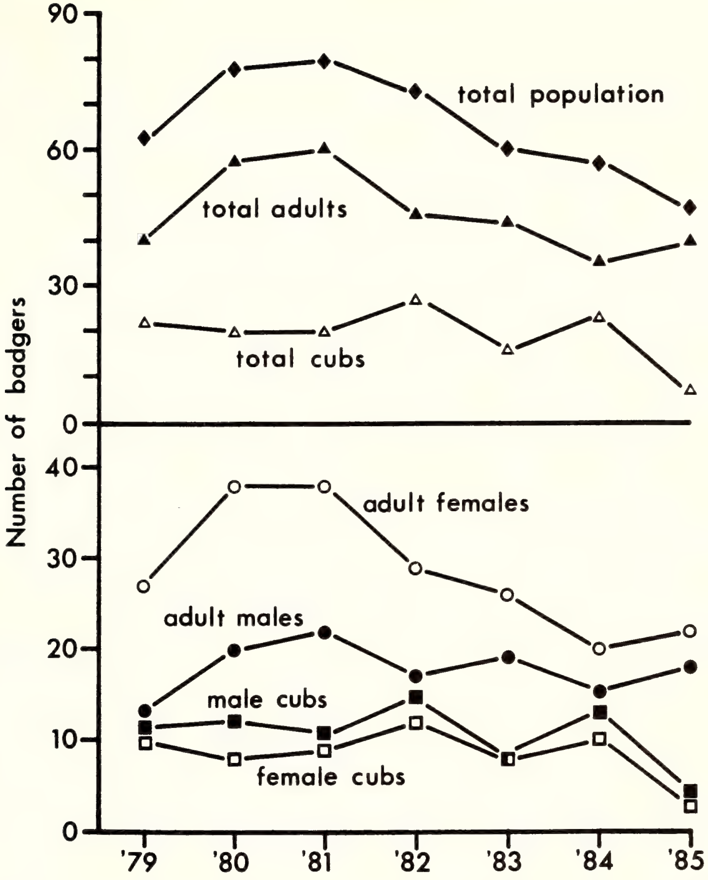

FIGURE 2 Population estimates for the fifteen social groups of badgers studied in north-west Bristol from 1979 to 1985. From Harris & Cresswell (1987).

captures over the years, showed that emigration out of the study area was also comparatively uncommon. However, there was considerable movement within the population, with 80% of male badgers and 44% of female badgers recaptured more than a year later having left their original social group. Most of these movements were simply transfers to an adjacent group, but some animals became solitary, whilst others travelled long distances.

Although more male badgers than females moved, the distances travelled were similar for both sexes (Cheeseman **et al.**, 1988). In fact the distance record was held by a female who was born in the Coombe Dingle area and run over on the M32 near the A4174 junction; if she had moved there directly she would have travelled 7.8 km, and much of this through the urban area. Other notable movement records include a male born in Stoke Bishop and run over 4.6 km away on the Clevedon road at Clarken Coombe. To have got there he had to cross the River Avon, and it is believed that he swam rather than using either of the bridges. There are unconfirmed reports of foxes being seen on the M5 bridge at Avonmouth (although there is no evidence to suggest that these foxes actually crossed the river), and staff have never seen a fox or badger cross the Clifton Suspension Bridge (S. Harris, unpubl. data). However, dispersing foxes have regularly been radio-tracked swimming the Avon in this area (Harris & Woollard, 1989), and another tagged badger was found drowned on the far side of the River Avon near the M5 bridge; it presumably died whilst trying to swim across the river.

FOOD OF BRISTOL'S BADGERS

To look at the food of badgers in Bristol, 2322 faeces were collected between December 1977 and December 1980 in the Stoke Bishop, Sneyd Park and Coombe Dingle districts. In addition, the stomach contents of 54 badgers killed throughout the city were examined. Details of the analytical procedures are given in Harris (1984).

Those studies showed that badgers in urban Bristol ate an enormous variety of food and these items are detailed in Harris (1984). Each item was assigned to one of six main categories and these are shown in Figure 3. Monthly variations were apparent in the food of Bristol badgers; most earthworms were eaten between December and May and other invertebrates from April to July. Vertabrate prey was rare at all times of the year, but was most common in May and June, when passerines (the major vertebrate food item) were breeding and presumably more vulnerable to capture. Vegetables were eaten rarely; there was an increase from February to April, when the badgers ate **Conopodium** tubers, but vegetables were

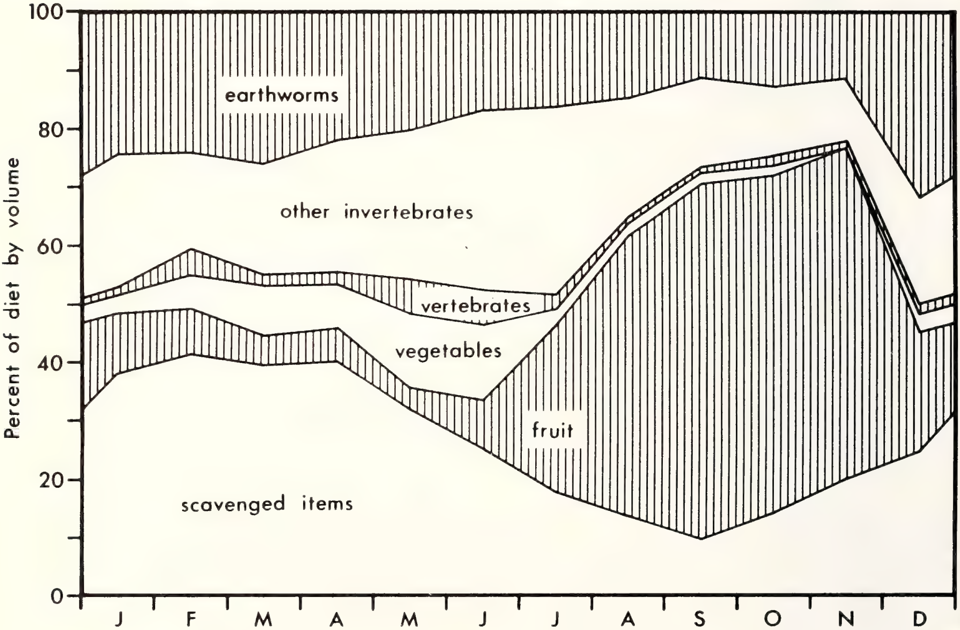

FIGURE 3 Monthly variations in the food of Bristol badgers, based on the analysis of 2322 faeces and 54 stomach contents. From Harris (1984).

most frequent in May and June, when damage to garden crops was most extensive. Fruit was of major importance in the diet from August to November; scavenged food was most frequently consumed from January to May. The pronounced seasonal variation in the diet of Bristol's badgers was in contrast to that of the foxes which, as described in the previous paper (Harris & Woollard, 1989), showed far less obvious seasonal trends in their diet. However, although there were seasonal differences in the proportion of particular food items eaten by foxes and badgers in Bristol, overall the diet of the two species was very similar.

The diet of badgers in Bristol is very different from badgers in rural areas, where they are specialist earthworm feeders (Kruuk & Parish, 1981; Neal, 1986). In Bristol earthworms were only used as a supplement to other food sources and the badgers were exploiting a range of food types. In gardens in particular a wide diversity of food types is available and Harris (1982) found that the badgers in north-west Bristol ate an increasing diversity of food types in response to the increased proportion of their foraging area that was covered by gardens.

DAMAGE CAUSED BY BRISTOL'S BADGERS

To see how much damage was caused by the badgers in Bristol, information was collected during a door-to-door survey in a 2.5 km^2 area including Stoke Bishop and Sneyd Park between October 1977 and September 1978. This included most of the badgers in the north-west population that were living in residential areas. The survey area contained 2306 households and from these 2224 completed questionnaires were obtained. Of these, 628 were from flats that did not contain a private garden and so were excluded from the analysis. Details of crop losses and damage attributed to badgers, compiled from the remaining 1596 questionnaires, are given in Tables 5 & 6. Many householders reported that although damage was a regular occurrence, they regarded it to be tolerable except during the drought summers of 1975 and 1976. Damage to garden crops was extensive during these two summers and for many households this was the only time when damage occurred. This was because other foods, particularly invertebrates, were severely limited in their availability. However, these summers were unusual bearing in mind that the sixteen-month period commencing in May 1975 was the driest period over the United Kingdom generally since records began in 1727 (Perry, 1977).

Compared to the impact foxes have on the local residents in the same area (Harris & Woollard, 1989), the badgers clearly presented more problems. The nature of the damage caused by badgers was different; they dug more in gardens, broke garden fences, damaged vegetable crops more often and caused more problems rifling dustbins. Although the badgers did take pets, such occurrences were very rare with most losses of pets attributable to foxes. However, to the keen gardener, urban badgers may pose a serious nuisance value and there is little that can be done to reduce their depredations (Harris, Jefferies & Cresswell, 1988).

THE FUTURE FOR BRISTOL'S BADGERS

The foxes in Bristol are very successful colonists; they are adaptable, have learnt to exploit the urban habitat and are not tied to specific breeding sites, so that if one breeding earth is destroyed they can quickly find another. The foxes are clearly here to stay. In contrast, the badgers are a relict population that has survived urban encroachment. The badgers are not very adaptable to change; if their main sett is threatened, they are unlikely to move to a new sett nearby, and the loss of a main sett usually results in the loss of that group of

TYPE OF CROP	No.	%
Carrots	283	17.7
Unspecified vegetables	41	2.6
Potatoes	32	2.0
Bulbs	14	0.9
Strawberries	12	0.8
Sweet corn	10	0.6
Parsnips	10	0.6
Gooseberries	7	-
Broad beans	7	-
Apples	6	-
Marrows	6	-
Raspberries	6	-
Dahlia tubers	5	-
Beetroots	4	-
Onions	3	-
Unspecified fruit	3	-
Courgettes	2	-
Blackcurrants	2	-
Plums	2	-
Parsley	2	-
Runner beans	2	-
Cabbages	2	-
Tomatoes	2	-
Mulberries	1	-
Brussels sprouts	1	-
Peas	1	-
Leeks	1	-
Lettuces	1	-
Thyme	1	-

TABLE 5 Number of households, excluding flats, in the Stoke Bishop and Sneyd Park areas suffering damage to, or loss of, garden crops attributable to badgers, based on 1596 completed questionnaires. Data from Harris (1984).

badgers. Since badgers are poor colonists (Kruuk & Macdonald, 1984), losses are unlikely to be replaced quickly. The low level of immigration into the city supports this belief.

With the recent rises in the value of land, particularly in north-west Bristol, the threats to some of the setts in the area could have serious consequences for the badger population. Similarly, enhanced access to the River Avon valley in south-east Bristol is likely to cause serious disturbance to the badger population. The conservation of Bristol's badgers poses a problem and is in need of urgent attention. Although the badger is found throughout much of Eurasia (Neal, 1986), it is rare in urban areas. Few cities outside Britain have substantial badger populations. Of the few that there are, the one in Copenhagen is best studied, but there the badger population is thinly scattered, numbering only 60 individuals over an area of 500 km^2, and these have suffered a 33% decline in the ten years up to 1985. Human disturbance and/or loose dogs appeared to play a major role in this decline (Aaris-Sørensen, 1987). Exactly the same pressures face the badgers in Bristol. Even though Bristol currently has the largest urban badger population in Britain, and hence the world, its future is uncertain. Clearly we have a unique

TYPE OF DAMAGE	No.	%
Rifling dustbins	262	16.4
Breaking fences	161	10.1
Digging holes in lawns	59	3.7
Digging dung pits in gardens	41	2.6
Digging in flower beds	36	2.3
Digging in compost heaps	16	1.0
Damaging fruit cages	10	0.6
Breaking gates	5	-
Digging up rockeries	4	-
Digging out bee/wasp nests	3	-
Damaging bird tables	2	-
Digging up drains	2	-
Digging under sheds	2	-
Attacking pet cats	2	-
Attacking/killing pet guinea-pigs	2	-
Catching fish in garden pond	1	-
Taking cat's food	1	-
Taking dog's food	1	-

TABLE 6 Number of households, excluding flats, in the Stoke Bishop and Sneyd Park areas suffering damage or nuisance from badgers, based on 1596 completed questionnaires. Data from Harris (1984).

ecological situation within our own city and we should value it as such.

ACKNOWLEDGEMENTS

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BATS IN AVON: THEIR DISTRIBUTION IN RELATION TO THE URBAN ENVIRONMENT

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INTRODUCTION

The formation of the Avon Bat Group in 1985 led to a surge in bat recording in the county. Of the 14 bat species breeding regularly in Britain, 12 have now been recorded in Avon, with breeding confirmed for six of these. This paper summarises our knowledge of bat distribution in Avon and discusses patterns of distribution and abundance in relation to the urban environment.

METHODS

Past distributions

Past records of bats in Avon have been collected from the literature. Important sources have been Rudge & Charbonnier (1909), Barrett Hamilton (1910) and Tetley (1941). The distribution of bats over the entire United Kingdom is given on a 10 x 10 km grid system by Arnold (1978). Mainland Avon extends into 26 such squares, though some of these squares are mainly composed of land in neighbouring counties. Other sources of information are listed in the bibliography. Additional data have been collected from specimens in the collection of the City of Bristol Museum and Art Gallery.

Several eminent mammalogists have worked on bats in Avon. Important among these were Coward (see Coward, 1907) and Harrison-Matthews (1937). Although these authors concentrated their studies on horseshoe bats in the Mendip caves, we now know that the population of bats there arises partly from a breeding colony in Avon (Jones **et al.**, 1988). More recently, Dr R.D. Ransome of Dursley (Ransome, 1968; 1971) has been conducting a long-term study on Mendip populations of the Greater Horseshoe Bat. Current scientific work on bat flight and echolocation at the University of Bristol has centred on populations in Avon (Jones & Rayner, 1988: 1989).

Between 1966 and 1979 annual mammal reports for the Bristol District and later for Avon were published in the Proceedings of the Bristol Naturalists' Society. These were edited by B.E. Jones, R.G. Symes and A.F. Jayne. The major bat records from these reports are summarised here. The Bristol Naturalists' Society has done much to create and stimulate interest in bats in Avon and important data on bat distribution are contained in articles published in the Society's Proceedings.

Recent records

Since 1985, records of Avon bats have been collated by the Avon Bat Group. These records are summarised on the distribution maps presented at the end of this paper, together with additional material collected from 1980 onwards by A.F. Jayne and data from specimens in the City of Bristol Museum and Art Gallery. Several categories of records have been assigned:

a) No identification possible. Often bats have been reported by the public either in roosts or when feeding outside. Often no attempt at identification has been made. These records are not included on the maps.

b) Bat detector records. The echolocation cries of bats consist of frequencies beyond the upper limit of human hearing. Bat detectors bring these frequencies into our hearing range and it is possible to identify certain species by listening to their calls through a detector. The Greater Horseshoe Bat, Lesser Horseshoe Bat, Serotine and Noctule can be reliably identified by experienced bat workers. It is possible to identify Daubenton's Bat, Pipistrelle and Leisler's Bat by using a combination of flight pattern observations and bat detector output. Other species are less easily identified from echolocation calls. Equipment for the analysis of ultrasound at the University of Bristol allows some species to be identified from high-speed recordings made in the field.

c) Photographic records. Some species have been identified from photographs and these are included in the species accounts.

d) Sight records. Some species can be identified from views obtained in roosts, but positive identification can sometimes be made only from handling bats (under NCC licence). Dead bats are also included in this category.

These last three categories of records are used in the species accounts. Records include those at breeding colonies, those at hibernacula and those which cannot be classified into either of these categories. Sometimes colonies are found which are almost certainly nurseries, but because young are not present, they cannot definitely be termed so.

SPECIES ACCOUNTS

The Greater Horseshoe Bat (**Rhinolophus ferrumequinum**)

Avon is one of the centres of distribution for this endangered species. In Britain, Greater Horseshoes are restricted to South Wales and south-west England. Many important hibernacula exist in the county and there is at least one breeding colony (Jones **et al.**, 1988). Data from the hibernacula suggest that another nursery site exists in Avon (R.D. Ransom, **pers. comm.**). After discussing the historical records, an account of the Avon breeding colony will be given, followed by a description of some important hibernacula.

Historical records

The Greater Horseshoe Bat has undergone a substantial reduction in numbers during the past hundred years (Stebbings & Arnold, 1987), though numbers in the Nailsworth area of Gloucestershire and in the Mendip hibernacula of Somerset have been fairly stable since a major population crash in the early 1960s (Ransome, in press). Late birth dates tend to occur after cold springs and few

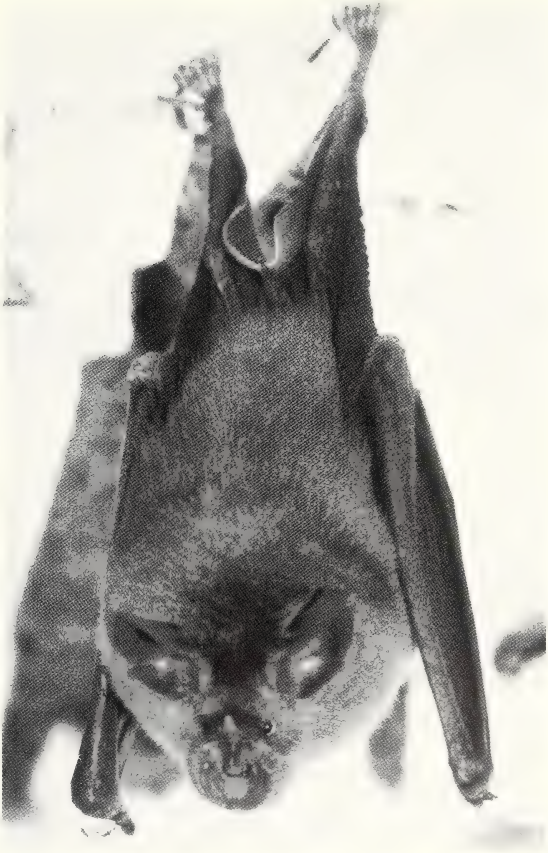


PLATE 1 The Greater Horseshoe Bat (**Rhinolophus ferrumequinum**).

youngsters then reach the hibernacula (Ransome, in press). This species appears to have declined because of disturbance effects, poisoning by certain timber treatment compounds, changes in farming practices and land use, and climatic changes (Stebbings & Arnold, 1987). Barrett-Hamilton describes the species as occurring in Clevedon [see also Charbonnier & Morgan (1898)], Hampton Rocks (near Bath) and at Westbury-on-Trym. Bell (1837) recorded Greater Horseshoe Bats in Bristol Cathedral and Clifton. Although individuals occasionally still turn up in the Avon Gorge, this species must have been reasonably widespread even close to the centre of Bristol at the end of the 19th century. A search of Bristol Cathedral in 1933 failed to reveal any trace of this species (Tetley). There are historical records from stone mines near Bath and from Banwell, Dundry, Wraxall, Ashton and Winscombe [**cit.** Tetley: see also Tucker (1925)]. The species can still be found in at least the first five of these areas today. Recorded by Bird in Burrington Combe in 1951.

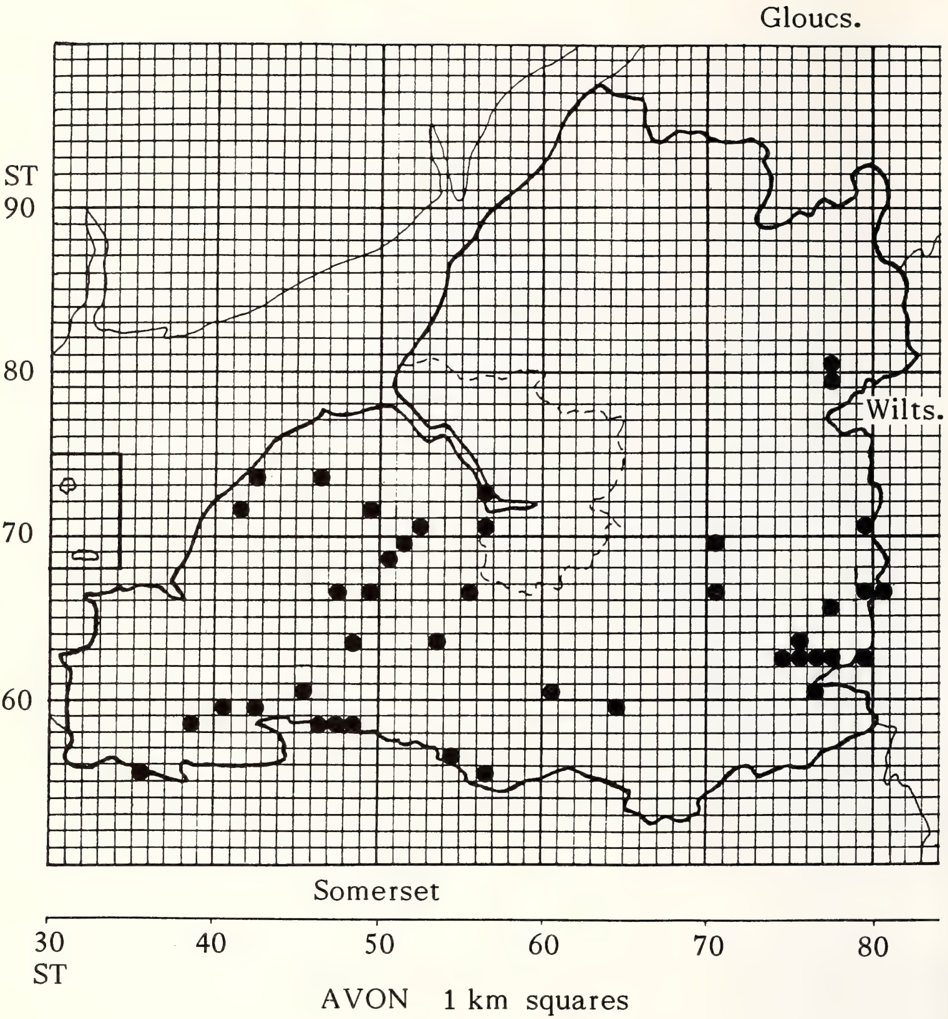

Gloucs.
ST
90
80
70
60
Wilts.
Somerset
30
ST
40
50
60
70
80
AVON 1 km squares

FIGURE 1 Greater Horseshoe Bat (**Rhinolophus ferrumequinum**). The nursery site is not shown.

Figure Legends

All Figures are distribution maps of bats in Avon, using a one kilometre grid system of mapping. All records are for 1980 onwards. Solid black circles are positive identification, solid black squares are bat detector or photographic records, solid black triangles are presumed nursery colonies (unless otherwise stated). Open diamonds represent records made from droppings collected at roosts.

1966-1979

There are records from Banwell, Loxton, Burrington Combe, Clevedon, Winford, Dundry, Easton-in-Gordano, Combe Down, Avon Gorge, Wraxall, Clifton Down, Upton Cheyney, Lansdown and Oakford.

The breeding colony

The Avon breeding colony of **Rhinolophus ferrumequinum** is one of only a dozen or so known in the United Kingdom. The site is now a Site of Special Scientific Interest and, at the time of writing, is being converted from an old stable block into houses. Roof space is being left for the bats. The colony was discovered in 1985, when an estimated 45 babies were born. Ringing of babies commenced in 1986 in collaboration with Dr R.D. Ransome. A total of 35 babies was born in 1986 (one died). Forty-two babies appeared in 1987 (plus one still-born), although some of these were obviously brought into the stable at an advanced age from another site nearby. Counts of juveniles in hibernacula also suggest that another nursery colony exists in Avon.

Most bats arrive at the nursery colony about a week before the first babies are born. Until then a large number frequent a priest-hole in a church porch in south-west Avon. Most of the bats caught here are old females, aged between at least three and 18-19 years. One male typically associates with the females in spring and autumn and probably remains throughout the summer. A small number of bats (usually <10) frequents the church in autumn after breeding but before moving to the hibernation sites. All of the females occurring at the church are likely to be breeding individuals, with no juveniles yet recorded. Peak counts have been 30 (1986), 31 (1987) and 36 (1988).

Hibernacula

During the winter many of the Avon breeding bats hibernate in the Mendips, though a range of other hibernacula is known. Two juveniles ringed at the nursery site have been refound at Mells in Somerset and refinds have also occurred at Wookey Hole in Somerset. Important hibernacula also exist in the Banwell area and near Bath. Over 40 bats may be found in some of the more important hibernacula. Natural caves and stone mines are especially favoured as hibernacula.

Smaller numbers of bats have been recorded in recent years from Walton-in-Gordano, Kelston, Upton Cheyney, Marshfield, Dundry, Winford, Compton Martin, East Harptree, Sandford and High Littleton. Bats are frequently counted in many Mendip caves. The Greater Horseshoe Bat cannot be described as common in Avon, though it is clearly widespread away from urban areas. A distribution map showing all records is shown (Figure 1). Most of the records so far obtained are from the south of the county, close to suitable hibernacula in the Mendips and Bath stone mines. There are records from 41 one km squares.

The Lesser Horseshoe Bat (**Rhinolophus hipposideros**)

The Lesser Horseshoe Bat is mainly restricted to western England and to Wales, though its distribution extends further to the north than **R. ferrumequinum.** Avon is again a national stronghold for this species. Only one nursery colony is known at present in the county.

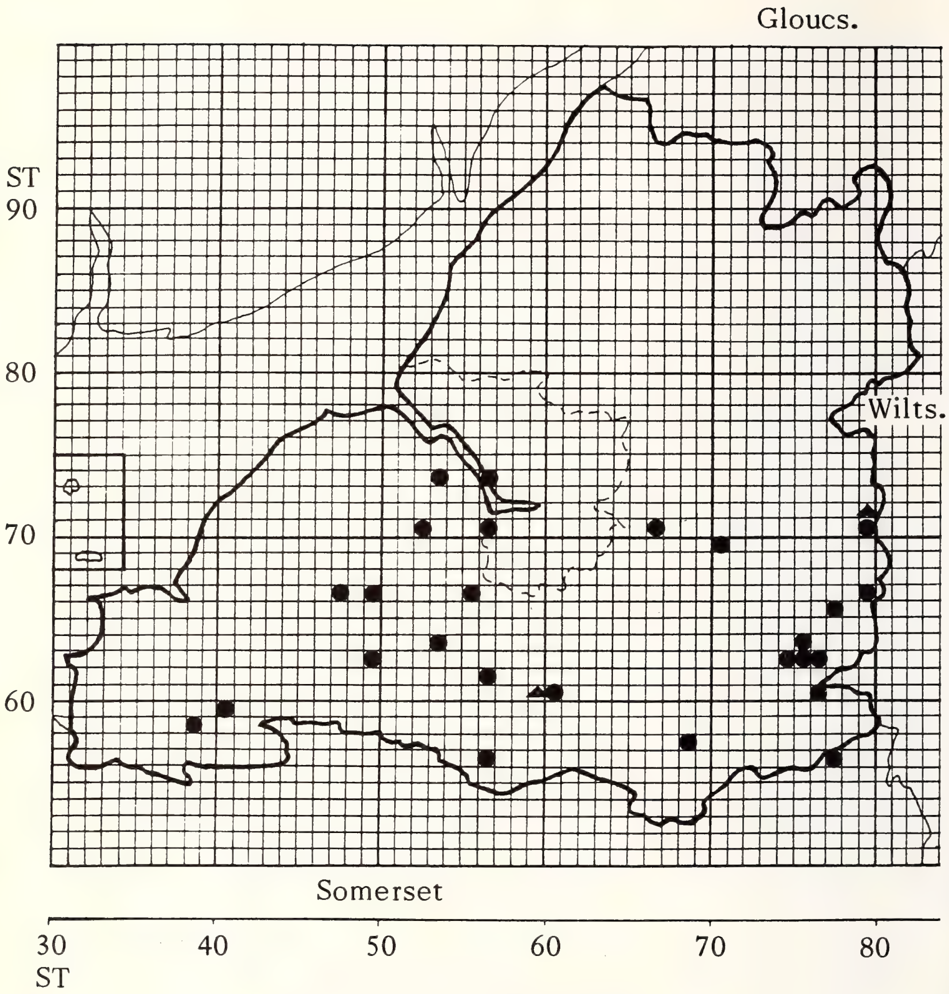


FIGURE 2 Lesser Horseshoe Bat (**Rhinolophus hipposideros**).

Historical records

Rudge & Charbonnier give records for Dundry, Westbury-on-Trym and Burrington. This species is described as being "somewhat rare, and has seldom been recorded north of the Avon" (Charbonnier & Lloyd Morgan, 1898). Tetley believed it to be commoner on the Somerset side of Bristol than on the Gloucestershire side, because of the "greater amount of suitable shelter". Historical records generally give the impression that the Lesser Horseshoe Bat was rare in the area about a hundred years ago. Charbonnier (1906) describes **R. ferrumequinum** as "frequent", **R. hipposideros** as "local and scarce". A similar impression is given by Witchell & Strugnell (1892). However Tucker (1925) describes the Lesser Horseshoe Bat as being very common in some areas and even documents an albino from Banwell. Tetley gave records for Westbury-on-Trym, Kingsweston, Henbury and Dyrham, and found a nursery near Bath in 1940. He also refers to a colony of "about 70" in a church tower a few miles north of Bristol. The Lesser Horseshoe Bat cannot be described as rare today, though its status relative to the Greater Horseshoe is difficult to ascertain. In known winter roosts of Greater Horseshoes, the Greater Horseshoe usually outnumbers the Lesser Horseshoe in Avon. For example, in the Bath area the counts of Greater and Lesser Horseshoes at such sites were 64 against 55 on 2 January 1987 and 114 against 48 on 2 January 1988. In the Banwell area similar counts consisted of 14 against 3 on 17 January 1987, 19 against 3 on 16 January 1988 and 13 against 11 on 4 April 1988 (R.D. Ransome, unpub. data). Many caves and mines contain only Lesser Horseshoes and no Greater Horseshoes however and, since these are not regularly surveyed, it is difficult to make a definitive statement about the relative status of these two species in the county. It is interesting to note however that Bird (1951) recorded only nine Lesser Horseshoes from two Banwell caves, with no Greater Horseshoes being found. Read's Cavern in Burrington Combe was a major hibernation site for Lesser Horseshoes in the 1940s, with 94 ringed there by Bird (1951).

1966-1979

Records for Hutton, Compton Bishop, Banwell, Burrington Combe, Ubley, Winford, Dundry, Easton-in-Gordano and Limpley Stoke.

Breeding sites

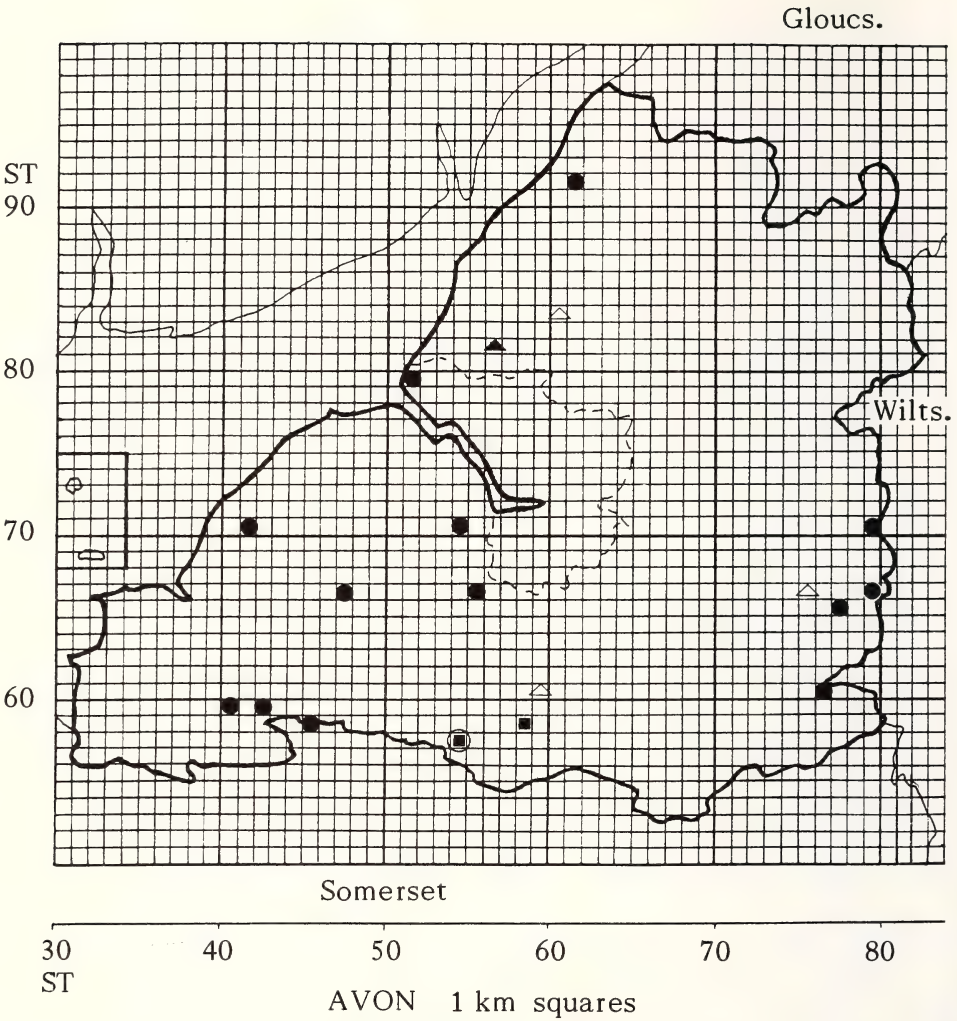
Only one breeding site is currently known in Avon. This is at Sutton Court, Bishops Sutton, in the roof of a manor house. Building work at the site disrupted the colony temporarily in 1988. In July 1986 about 70 adults were counted; about a half to a third had babies. In June 1987, 30 to 35 adults were counted, a few with very small young. In 1988 an estimated 58 youngsters were counted. There was a colony near Marshfield in the mid-1980s that no longer seems to exist. Other nursery colonies will undoubtedly be found in Avon in the near future.

Hibernation and non-breeding sites

Lesser Horseshoe Bats are widespread in Avon out of the breeding season. They do not occur in clusters during hibernation. At least 35 were found in one stone mine near Bath in 1987 and counts frequently reach double figures in caves. The distribution of **R. hipposideros** is given in Figure 2. Lesser Horseshoes have been recorded in fewer 1 km squares than Greater Horseshoes (28 against 41), though their distribution is very similar. Lesser Horseshoes are not found in urban situations, though they do occur in suitable habitats on the edge of Bristol (e.g. the Avon Gorge).

Whiskered Bat (**Myotis mystacinus**)

The Whiskered Bat **Myotis mystacinus** and Brandt's Bat **M. brandti** are very similar in appearance and can only be separated in the hand. Brandt's Bat was not discovered in Europe until 1958, so all historical records must refer to **M. mystacinus/brandti** (bats were all previously lumped as Whiskered Bats). Recent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AVON 1 km squares

FIGURE 3 Whiskered/Brandt's Bat (**Myotis mystacinus/brandti**). The open triangle is **M. mystacinus/brandti**, black triangle is nursery colony of **M. mystacinus**, black square is positive record of **M. brandti**, black circle positive **M. mystacinus**. The black square surrounded by an open circle is where both species have been positively identified.

records are separated into **M. mystacinus**, **M. brandti** and **M. mystacinus/brandti**. These species are not easily identified with a bat detector.

Historical records: **M. mystacinus/brandti**

Barrett-Hamilton states that Whiskered Bats occurred in Somerset and

Gloucestershire. Charbonnier and Lloyd Morgan (1898) describe Whiskered Bats as "common near Bath". Witchell & Strugnell (1898) considered the Whiskered Bat to be "very common" at Keynsham and towards Bath, with no records north of the Avon. Harting (1888) cites the Whiskered Bat to be commoner than the Pipistrelle near Bath. Rudge & Charbonnier believed the species to be "sometimes abundant in old roofs and occasionally in caves and quarries". Dundry is given as one cave site. They cite a record of a colony of nearly 100 at Willsbridge in July 1888, with many of the females with young. Tetley lists Claverton, Ashton [see also Tucker (1925)], Little Stoke, Litton, Dyrham and Bath as further sites. Stoke Gifford is a further site (Tetley **cit.** Walling, 1955). Burrington is a locality given by Barrett-Hamilton. Bird (1951) recorded Whiskered Bat at Burrington Combe. The Whiskered Bat is generally distributed over Britain north to the Scottish border, with a few specimens having recently been found in Scotland.

1966-1979

Records for Abbots Leigh and Combe Down referred to **M. mystacinus.**

The breeding site

A colony of about 20 Whiskered Bats was discovered in the roof space of an old house at Compton Greenfield in 1988. The site is now known to be a nursery.

Other sites

Whiskered/Brandt's Bats are frequently encountered in small numbers in caves and stone mines during the winter. Their distribution is shown in Figure 3. Whiskered Bat has been recorded from 15 one km squares; Brandt's from two. The maximum number recorded in one cave system has been three at Brown's Folly near Bath in 1987. The Whiskered Bat is generally distributed and has been found in semi-urban areas at Clevedon and Long Ashton. It is not a species typically found in urban situations, though sometimes turns up in residential areas on the edge of Bristol.

Brandt's Bat (**Myotis brandti**)

There are three positive records of this species in Avon. One was found dead at Sutton Wick near Chew Valley Lake (Symes, 1973). One male was found dead in a Blagdon house during August 1987 and a male was identified in a southern mine by R.S. Cropper in January 1988 (Figure 3). The species is not often positively identified in Britain, but probably has a widespread distribution up to the Scottish border.

Daubenton's Bat (**Myotis daubentoni**)

Daubenton's Bats are often found close to water. They regularly hunt for insects by flying close to the water surface and combined bat detector and visual tracking can identify this species with reasonable certainty. Daubenton's Bats are found throughout mainland Britain. No breeding colonies have been found in Avon during recent years, though several must exist.

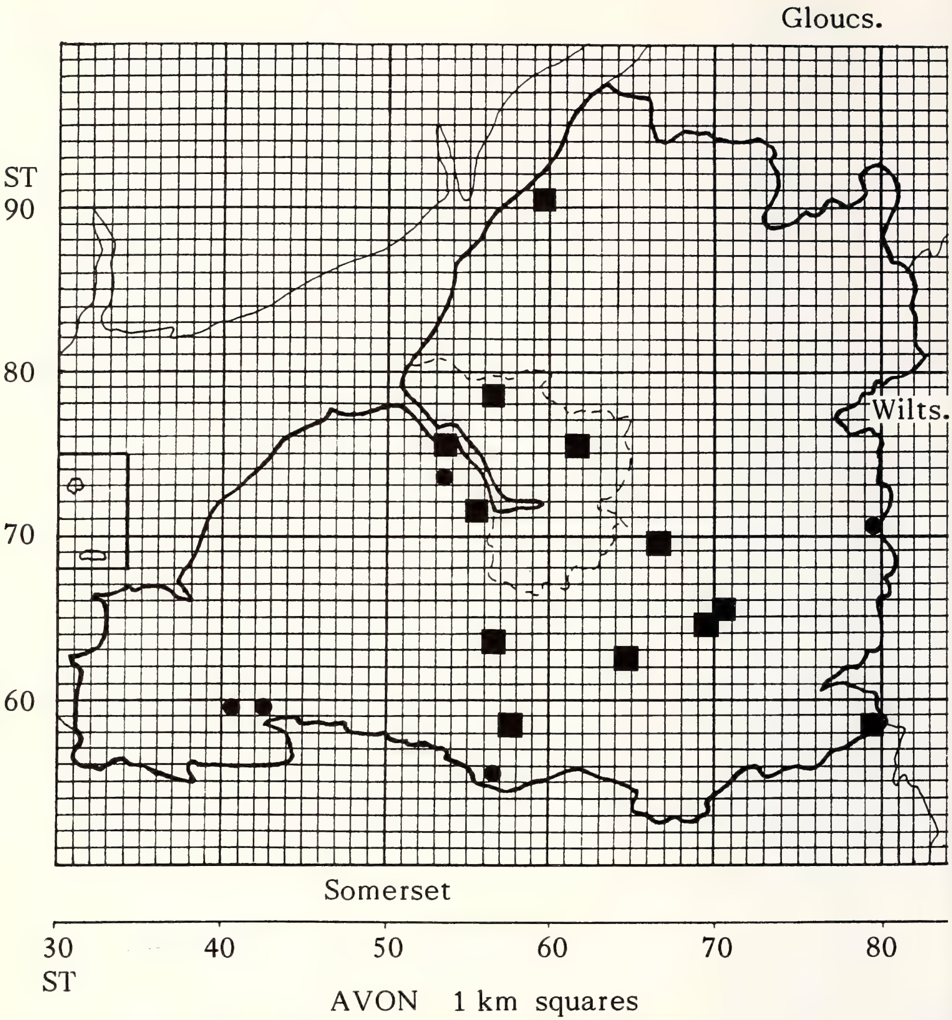
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FIGURE 4 Daubenton's Bat (**Myotis daubentoni**).

Historical records

Not recorded by either Rudge & Charbonnier or by Tetley, which is surprising given that we now find the species in many parts of Avon. Daubenton's Bat was first recorded in Gloucestershire only in 1957 (Collins, Hayward & Iles, 1957). There were no records for Avon between 1966 and 1979. Roosting sites are still difficult to locate, however.

Recent records

Most of the recent occurrences for Avon were made from bat detector with observation records (Figure 4), with records from 17 one km squares. Roosting bats have been found only at Abbots Pool, (Abbots Leigh: up to six to eight have been found in a tree roost here), East Harptree Combe, Marshfield, Sandford and Banwell (solitary bats found during hibernation at the last four sites). The most recorded in one place has been 12 at Abbots Pool. The species is often seen over water bodies in parkland close to Bristol (e.g. Blaise Castle, Ham Green Lake) and there is an urban record for Eastville Lake (summer 1988).

Natterer's Bat (**Myotis nattereri**)

Generally distributed throughout Britain, with the exception of north-west Scotland.

Historical records

"This bat has occurred in caves near Bath and in Gloucestershire, so there seems no doubt that though probably very rare, it does occur in the district" (Rudge & Charbonnier). By 1941 Tetley thought this species to be widely distributed in the Bristol district, but probably not abundant anywhere. He listed records from near Bath, Compton Bishop, Blaise Castle Woods and Dyrham. Recorded from Burrington Combe by Bird (1951). Walling (1955) cites records for Blaise Castle, Dyrham and Purdown, near Bristol.

1966-1979

Recorded twice in the mammal surveys but no details of sites provided.

Recent records

Natterer's Bat has been identified from 17 one km squares in Avon since 1984. All records are for single individuals, spread over the year (Figure 5). Included in the data are one bat-detector/observation record and one photographic identification. The species has turned up on the edge of Bristol, so may be expected to occur in parkland near the centre (e.g. Blaise Castle). A summer colony was found in Nailsea in 1988; this may have included breeding females.

Bechstein's Bat (**Myotis bechsteini**)

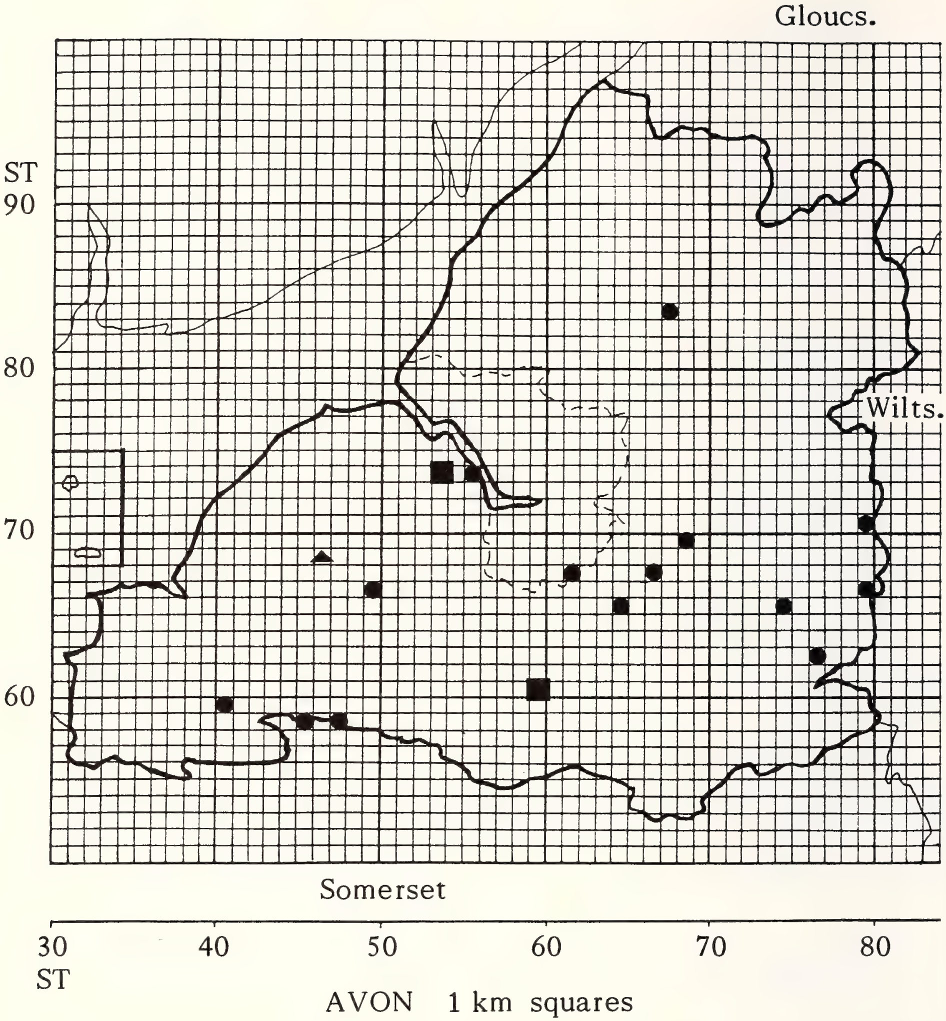
A rare species confined to central and southern England. Has recently turned up in Somerset and Gloucestershire.

Historical records

This species was more widespread in Britain during the Pleistocene age, it being a forest dwelling bat and probably quite common when much of Britain was covered with natural woodland. Tetley cites a record from 1920-21 when a skull, dated to the Pleistocene, was found in Burrington Combe. There are no records from more recent times for Avon.

Pipistrelle (**Pipistrellus pipistrellus**)

This is the smallest, commonest and most widespread British bat species and the one most often seen in urban situations. Pipistrelles are found throughout mainland Britain and on some offshore islands. They are often found in buildings,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AVON 1 km squares

FIGURE 5 Natterer's Bat (**Myotis nattereri**).

both in the summer and during the hibernation period.

Historical records

"Not uncommon in old houses and caves" (Charbonnier, 1906). Rudge & Charbonnier state that this species is sometimes found in caves, but this is now considered unlikely and probably resulted from incorrect identification of Whiskered Bats. They cite a "white-winged" individual flying at Frampton Cotterell in 1891. Charbonnier & Lloyd Morgan (1898) describe the Pipistrelle as common on the Gloucestershire side of the Avon, rare on the Somerset side. This statement

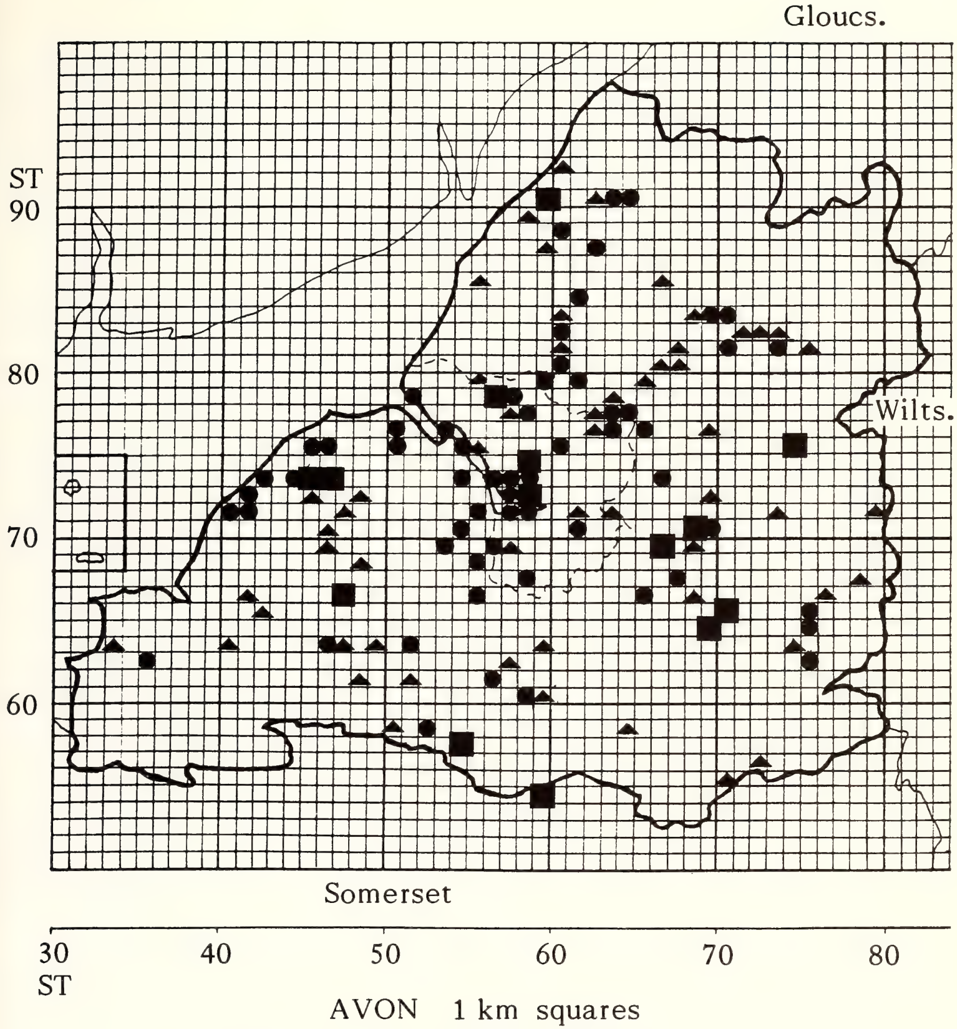
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FIGURE 6 Pipistrelle (**Pipistrellus pipistrellus**).

is unfounded today. Tetley believed that Pipistrelles were very common in the Bristol district, though they may be outnumbered in some areas by Whiskered Bats. We now consider the Whiskered Bat to be considerably scarcer than the Pipistrelle. Tetley cites a record of "about a dozen" in company with about 70 Lesser Horseshoes in a church tower a few miles north of Bristol. There are records from Eastville and Coalpit Heath in Bristol (Walling, 1955).

1966-1979

Records from Westbury-on-Trym, Fiddler's Bottom (near Cromhall) and Chilcompton.

Recent records

The Pipistrelle turns out to be the most widespread bat in Avon, with records from 130 one km squares (Figure 6). Its distribution is markedly different from that of the horseshoe bats and the myotids which tend to occur in areas close to caves. There are several regions from urban areas and the centres of Bristol, Bath, Clevedon, Portishead and Weston-super-Mare have all produced Pipistrelle records.

Breeding colonies

The largest nursery colony was 332 at Blagdon, with other colonies of 243 at Butcombe, 190 at Coalpit Heath, 140+ at Frenchay Park, 112 in Chipping Sodbury and Bath, 102 in Henbury and 50+ at Aust church. Pre-breeding colonies and nurseries are extremely mobile, both within a year and between years. For example, the large colony at Blagdon no longer exists at the same site. Fifty-eight summer colonies have so far been found. Most of these (45) have been in modern (post-war) houses or buildings.

Hibernation sites

Bats in hibernacula are usually found singly or in small numbers. Most bats have been found in buildings, with two bats being reported by double-glazing companies as hibernating in window frames. Four were found hibernating in a tree in Ashton Court, 10 in buildings at Patchway.

The Serotine (**Eptesicus serotinus**)

The Serotine is a bat of southern Britain and the Midlands. It is widespread in distribution, but nowhere very common.

Historical records

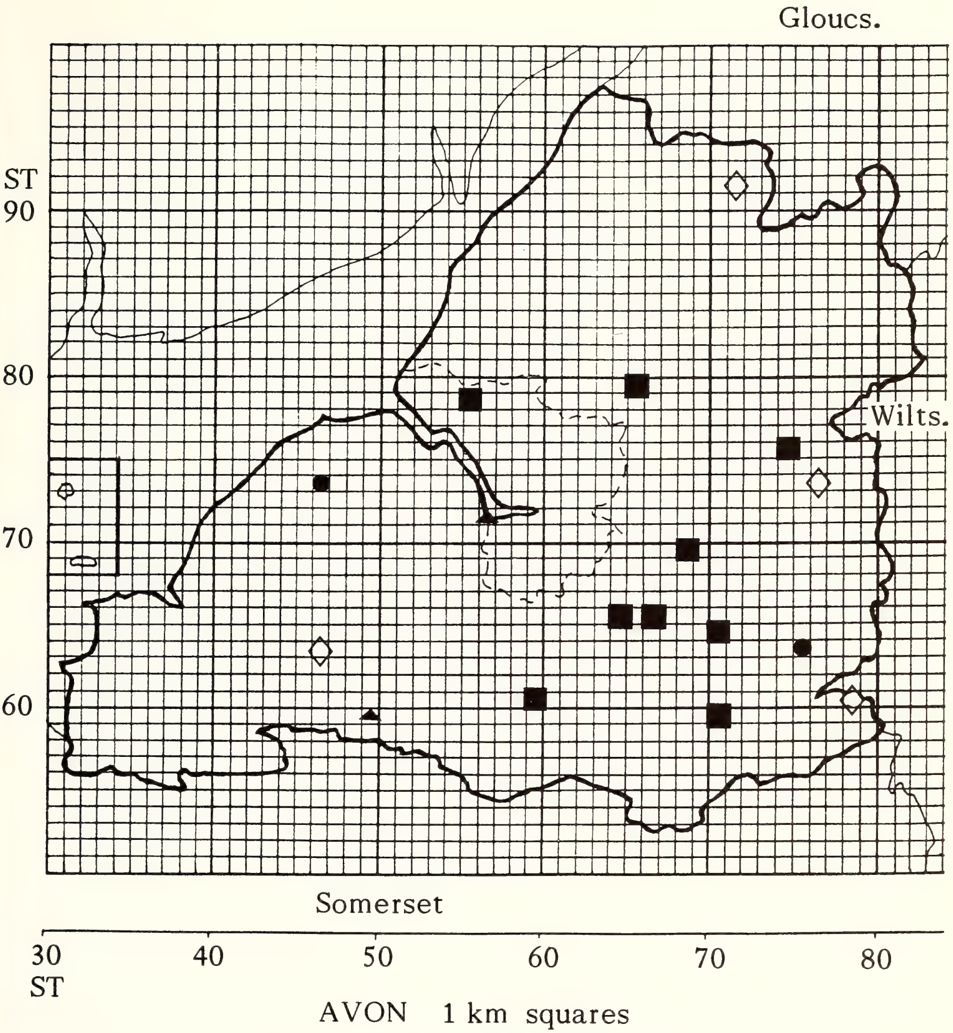
Barrett-Hamilton states of the Serotine "in the west it is almost unknown, or has escaped notice". There are no records documented by either Rudge and Charbonnier or by Tetley, although Tetley acknowledges that the species may have been overlooked. There were no records between 1966 and 1979. Serotines can be mistaken for Noctules when flying, though the use of bat detectors now makes it easy to separate the two species. There have been occurrences in 13 one km squares since 1985, seven of these from bat detector and simultaneous observation records (Figure 7). Droppings thought to be associated with this species have been found at three further sites. With this species appearing at Blaise Castle and in Bath, it may be quite widely distributed in suburban situations.

The breeding sites

One nursery colony consists of at least 20 bats in the roof space of an old house in Blagdon. The roof space is shared with a colony of Brown Long-eared Bats. Several bats were found in a summer roost at a house in Bower Ashton.

Leisler's Bat (**Nyctalus leisleri**)

Leisler's Bat is scarce but widely distributed in southern Britain. It is very similar to the Noctule, though it appears much smaller in flight and has a different echolocation pulse rhythm when heard on a bat detector.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AVON 1 km squares

FIGURE 7 Serotine (**Eptesicus serotinus**).

Historical records

Tetley cites a record of one in Winscombe during October 1915 [see also Tucker (1925)]. Harrison Matthews & Mayes (1949) give an account of a dead female carrying a live youngster at Stoke Bishop, Bristol in 1948.

Recent records

Since 1948 there have been eight records which suggest that a population exists in suburban Bristol, somewhere between Clifton and Lawrence Weston. There are two specimens in Bristol Museum, one from Clifton (dated 15 September

1972); one from Sneyd Park (dated as received on 25 March 1978). One was found inside a house at Lawrence Weston on 17 October 1986. There are bat detector/ observation records from Abbots Pool (Abbots Leigh) on 5 April 1987 and on 12 August 1987. In the summer of 1988 a young bat was handed in by a resident of Clifton, although it is not known where the bat originated. A female was found cat-damaged in Clifton on 6 February 1989. This individual died after two days in captivity. Another bat was discovered in Cotham on 18 August 1989. This species probably breeds somewhere in residential areas of Bristol and may be quite closely associated with the urban environment there.

The Noctule (**Nyctalus noctula**)

A widespread and fairly common species in Britain, though not usually found in Scotland.

Historical records

Barrett-Hamilton cites records of bones dating to the Pleistocene found at Banwell, Burrington Combe and Hutton. Records of breeding in the Mendip caves are unlikely to be reliable. Charbonnier & Lloyd Morgan (1898) state that the noctule is "common in old trees in suitable localities, the females being the more abundant". Charbonnier (1906) stated that the species was "common and generally distributed"; Tucker (1925) preferred "apparently local, but widely distributed". Knight (1902) described a colony of about 60 in a tree at Congresbury. Rudge & Charbonnier believed Noctules to be "generally distributed and sometimes abundant" and state that colonies of 20-60 bats have been found, but give no details of localities. Tetley gives records from Congresbury and probable records from Patchway and Durdham Down in Bristol. Tetley considered the Noctule to be "common and generally distributed", which is probably a fairly accurate statement today.

1966-1979

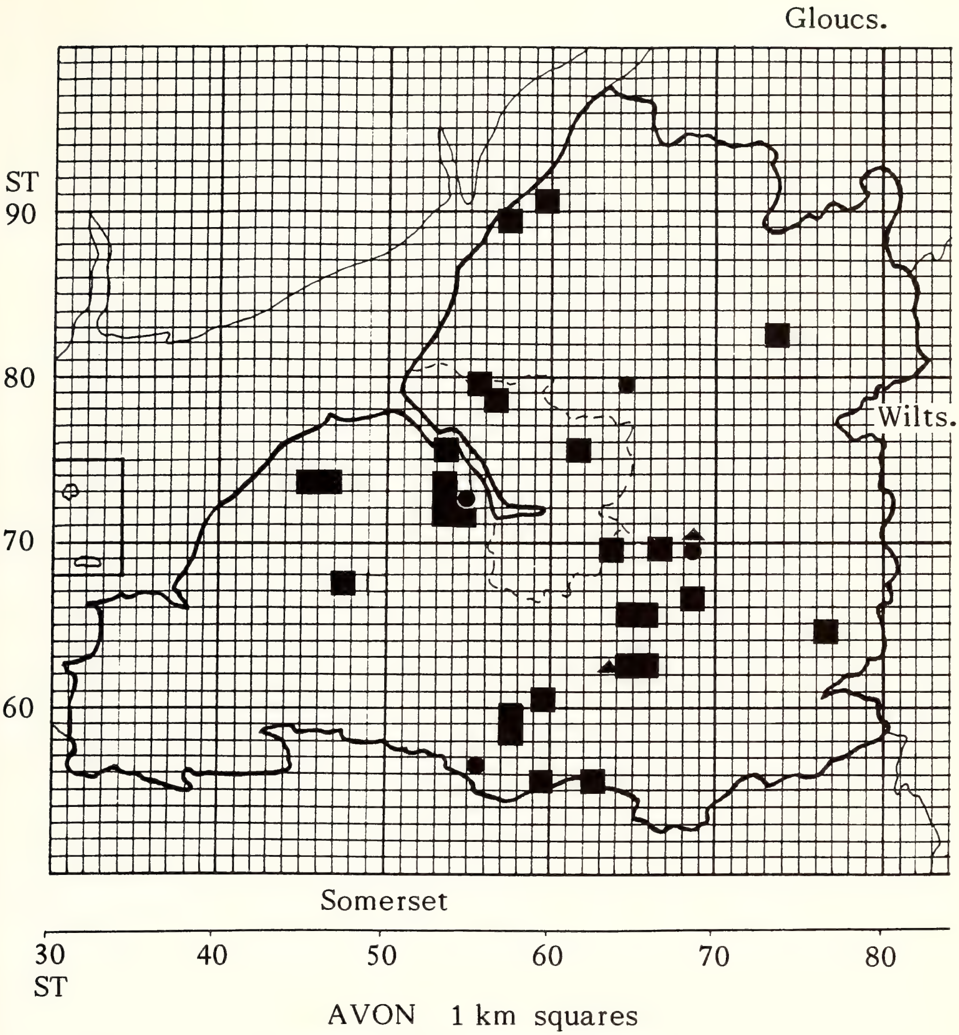
A record from Wraxall and a couple of flight records from unspecified localities.

The breeding sites

One known breeding site in Avon is in a pine tree at Willsbridge. About 135 bats were counted out of here in 1987 (one carrying a baby) and bats sometimes roost in another tree away from the main roost. In 1988 the main roost was occupied between about 10 May and 2 August. A partially albino bat was sighted on one occasion. Weekly counts varied considerably, the maximum recorded being 112 on 17 May (pre-breeding). This roost may be one of the largest in the country. Another summer roost occurs at Hunstrete.

Other recent records

The Noctule is easily identified with a bat detector and is often detected at considerable distance. It is often found roosting in trees and the one hibernation record is of three (two males, one female) found in a limb felled from an oak tree in West Harptree. Another was found hibernating in a tree in Ashton Court. The distribution of the Noctule in Avon is shown in Figure 8. The largest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AVON 1 km squares

FIGURE 8 Noctule (**Nyctalus noctula**).

numbers recorded in one place were 12 at Ham Green Lake in the spring of 1986 and an interesting urban record of more than 25 bats at Eastville Lake, summer 1988. Noctules have been recorded from 32 one km squares since 1980.

The Barbastelle (**Barbastella barbastellus**)

A rare species confined to southern Britain.

Historical records

Rudge & Charbonnier cite an 1898 record from the Tramway Centre in

Bristol. Three turned up at Dyrham between 1930 and 1940 (Tetley). Barrett-Hamilton cites the species as breeding in the Mendips. There are no recent records.

Grey Long-eared Bat (**Plecotus austriacus**)

Grey Long-eared Bats are difficult to distinguish from Brown Long-eared Bats. There have been no records of **P. austriacus** in Avon. Although **Plecotus** bats are rarely captured for positive identification, all of those so far handled in Avon have proved to be **P. auritus.**

Brown Long-eared Bat (**Plecotus auritus**)

A common species throughout Britain.

Historical records

Plecotus austriacus was not considered by previous writers as a species likely to occur in Britain, so all records were for **P. auritus.** Rudge and Charbonnier cite it as "generally distributed". Charbonnier & Lloyd Morgan (1898) described the Long-eared Bat as "fairly common" and Knight (1902) described it as "common". Charbonnier (1906) considered the species as "common and generally distributed", as did Tucker (1925). Tetley gives records from Burrington Combe, Compton Bishop and Nailsea. Records were also provided for Pucklechurch, Henbury, Bristol University and Fishponds. Walling (1955) gives records from Staple Hill and Purdown.

1966-1979

Records from Stapleton, Saltford, Hawkesbury, Nailsea, Winterbourne church and Lansdown.

Recent records

Recent records (Figure 9) have been divided into those where **P. auritus** was definitely identified and those for **Plecotus** sp. (likely to be **P. auritus**). **P. auritus** has been identified in 45 one km squares since 1980.

Breeding colonies

Twenty five colonies have been found since 1980, most of these probably containing breeding individuals. Most colonies surveyed contained about 15-20 bats. One was in a stable block at Winscombe, but this was treated with chemicals harmful to the bats which have now left. Another is in the roofspace of an old house in Blagdon, in a separate area of roofspace from a Serotine colony. There is a long-established colony at Chewton (Keynsham) in the roofspace of an old house where about 26 adults occupy the roost before the young are born (Howard, 1988). A further roost of 10+ was destroyed in farm outbuildings at Pensford. Most colonies are in old buildings or in farm outbuildings. This species is mainly found away from urban areas close to farmland and older buildings.

Hibernation sites

The species turns up regularly as ones or twos in stone mines and caves.

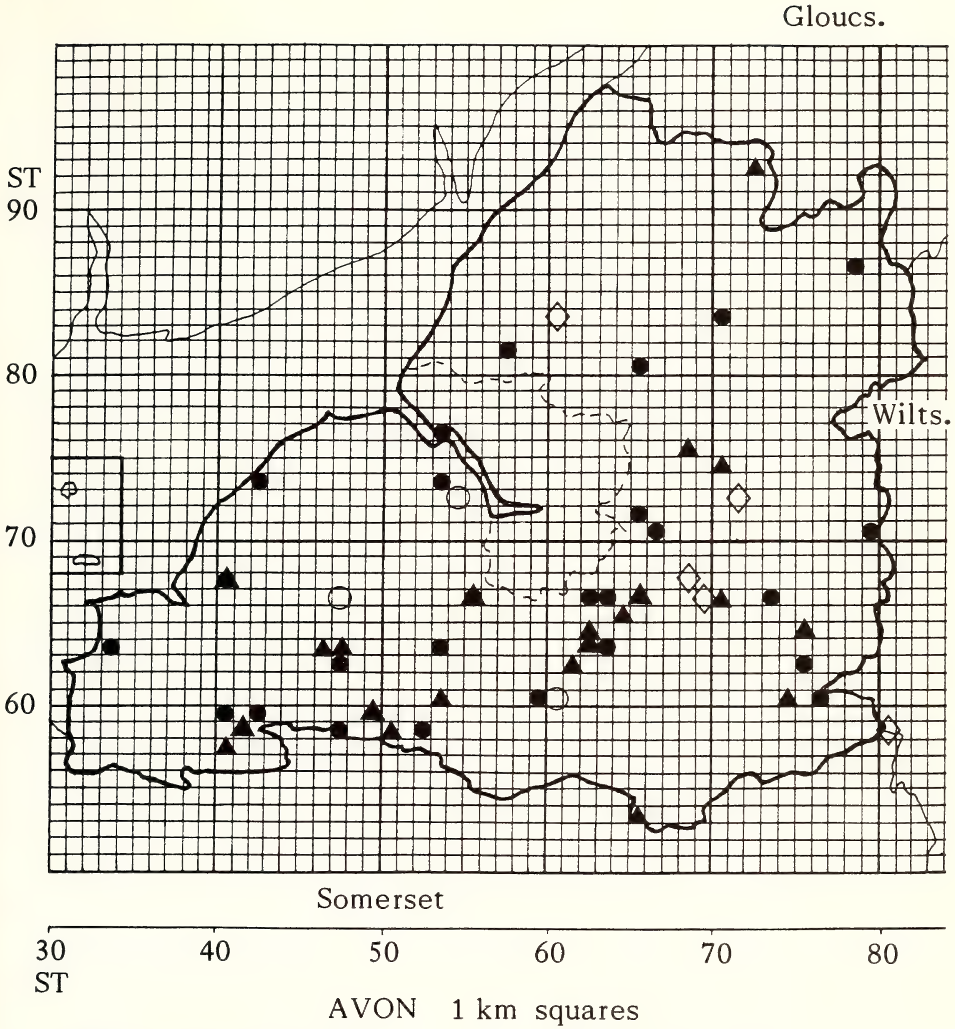

FIGURE 9 Long-eared Bats. Open circles are **Plecotus** spp., closed circles **P. auritus**, black triangles presumed nursery colonies of **P. auritus**.

Two were found hibernating in a stone wall at Walton-in-Gordano. The numbers found during hibernation are small compared with numbers found in the summer, so other hibernation sites (perhaps trees) may be used frequently.

DISCUSSION

Bats are not often found in the centre of cities, probably because of the low levels of insect food associated with the urban environment. The most urban species is the Pipistrelle, which is sometimes found in the centres of Bristol and Bath. Whiskered Bat, Serotine, Noctule, Leisler's Bat, Natterer's Bat, Daubenton's

Bat and Brown Long-eared Bat can be found in suburban situations and in parkland close to the city centre. Even the sensitive horseshoe bat species sometimes appear in woodland habitats and in caves close to the city.

We are fortunate in having a wide range of British bat species in Avon. Although only the Pipistrelle is commonly found in the cities, most other species are dependent upon man-made habitats for breeding (roofspaces, buildings) or for hibernating (stone mines, buildings). All of the summer colonies of bats found in Avon so far (82) have been found in buildings except for two tree roosts. Bats have often suffered from human activities such as changes in land use, although they have also benefited to a lesser extent through the provision of roosting sites. Records of bats in Avon are always welcomed by the authors and any information will add to our knowledge of the distribution of these animals in the county.

ACKNOWLEDGEMENTS

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WILDLIFE AS PESTS IN URBAN AVON

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ABSTRACT

The wildlife of urban Avon sometimes conflicts with Man's interests. The factors affecting the associations between Man and wildlife are described, and it is shown that whilst many of the 'problem animals' have been introduced to this country, even indigenous species give rise to complaints of nuisance, serious damage, or of disease transmission. The significance of such problems, and the contemporary physical and chemical techniques of resolving them, are described.

INTRODUCTION

Biological recording schemes throughout the country tend to have a common feature; "pest" species are rarely, if ever, recorded in reports on fauna or in local natural history publications. Usually, little interest is shown by naturalists in them and in some instances they are deliberately excluded from systematic lists. However, it would be unfortunate if the public, especially youngsters, were given the impression that wildlife presented no pest problems in Avon's urban situations.

There are species of wildlife which have taken advantage of Man, particularly in his urban environment, and have developed special relationships, some of which are not welcomed by both parties. There are definitions of "pests" in many works; if they are discussed in rural areas they tend to be regarded as "vermin". Legislation 'tags' some species with a pest or vermin label. Some wildlife species in urban Avon are accused of causing damage to property, food and to garden crops, preying on pets, fouling, being an irritation or nuisance because of noise or just because of being present and sometimes of being implicated in disease transmission. Man has created, often inadvertently, conditions favourable to the development of certain species, but when 'pest' situations arise his attempts to resolve problems do not often lie in altering those conditions. In some instances offending creatures are indigenous species, in others they are species which have been introduced wittingly or otherwise by Man. However, one man's pest can be another man's pleasure and individual attitudes to wildlife vary enormously, this being the case especially in tolerance or acceptance of wildlife in urban situations.

This account of wildlife problems in urban Avon is based on the combined experience of the authors during over 20 years in the Ministry of Agriculture, Fisheries and Food's Wildlife and Storage Biology Unit (WSB), which is part of the Agricultural Development and Advisory Service and its predecessor the Regional Pests Service, in answering queries from the public, local authorities, pest control contractors, commercial companies, press and media. It is not possible to discuss all the species which have caused problems and inevitably it will be necessary to be selective in looking at the ways in which particular animals (mainly mammals, birds and insects in storage and hygiene situations) affect Man in his urban environment in Avon.

WILDLIFE versus MAN

Some wildlife have been particularly successful in Avon's urban areas because they have been able to use buildings or Man's structures for resting, nesting and breeding, or for roosting. Some have taken advantage of accumulated food sources, but have not necessarily needed to use buildings, while others seem still to be learning to utilise opportunities offered in urban situations.

INSIDE BUILDINGS

Some species are entirely, or almost so, committed to buildings or to man-made structures. The house mouse (**Mus domesticus**) (Plate 1) and the ship or black rat (**Rattus rattus**) are the mammals which can be regarded as being totally committed in this way. The house mouse is a common problem in many properties, a MAFF survey (MAFF, 1975) showing that 4% of premises inspected by local health officials between 1966 and 1979 were infested by house mice; there is no reason to think that this national picture did not apply equally in Avon. Whilst Tetley (1940) considered that the **Rattus rattus** population had increased considerably over the preceding forty years, the black rat is now thought likely to have been eliminated from Avon, there having been no recent reports from Clifton or from Avonmouth, the last-known locations for the species (Jayne, 1979; R. Bevan, **pers. comm.**). Richards (1989) reported that whilst the black rat is now so rare that it has been considered for inclusion in the Red Data Book, its decline in the U.K. is in contrast to the situation in mainland Europe where, in inland parts of Holland and Belgium for instance, it has expanded its distribution substantially. He stressed that a possible resurgence in the U.K. cannot be ruled out.

Both of these species breed inside buildings and search for food almost entirely indoors in urban locations. None of the bird species is restricted in habitat to this degree, although observations (CFBC) on populations of feral pigeons (**Columba livia**) at Avonmouth have shown discreet flocks of up to 50 birds living most of their time in warehouses.

It is particularly amongst the insects that dependence on Man's buildings and structures becomes very obvious. Many species of stored products and hygiene pests cannot survive outdoors in this country, most having been introduced from overseas. In previous years MAFF staff based in Bristol were involved in carrying out regular inspections of food materials imported into Avonmouth and in surveying grain and feed premises. The insects imported into the U.K. over many years were reported by Aitken (1975 & 1984). None of the stored products insects found in Avon are species which are also found in the field: most species live in their food material.

Grain stored in granaries and mills in Avon has been frequently found infested with grain weevils (**Sitophilus granarius**) and saw-toothed grain beetle **Oryzaephilus surinamensis**), both species being able to survive in unheated premises. Strains of saw-toothed grain beetle, which were highly resistant to the organophosphorus insecticide malathion, were detected on imports some years ago. "Chinese Whispers" amongst dockers almost led to a strike when "resistant **Oryzaephilus**" referred to by scientists became a new strain of "Oriental syphilis"! Insects found in heated premises such as flour mills and bakeries have included both of these species, which are cold tolerant, and others such as the mill moth (**Ephestia kuehniella**) and the confused flour beetle (**Tribolium confusum**), (which for many years was confused by entomologists with the very similar rust-red flour beetle [**T. castaneum**]). These species are unable to breed outdoors in the U.K., but some of these tropical insects are surprisingly cold hardy, as was seen

PLATE 1 The House Mouse (**Mus domesticus**).

when rust-red flour beetles, the most commonly imported beetle, were found thriving in animal feed residues in railway trucks when the winter air temperature was -2°C. Any checklist of the fauna of food and animal feeding stuffs would have to include the many species of mites (Acarina) such as **Acarus siro** (flour mite) (Plate 2) and **Glycyphagus domesticus** (house mite, or grocers' itch mite), and of booklice (Psocoptera), which are often found in unprocessed foodstuffs and against which the food trade has to maintain constant vigilance.

The importance of heat to the survival of imported species is well illustrated by the success of the tropical Pharoah's ant (**Monomorium pharaonis**) in centrally heated buildings such as office blocks, laundries and kitchens. This minute insect nests inside buildings and frequently goes unnoticed until many colonies have built up and ants are seen in food containers and, of more concern, in medical units where their taste for blood can mean their appearance in most unwelcome situations! Beatson (1972) reported on the disease hazards these insects present. Cockroaches such as the oriental cockroach (**Blatta orientalis**) have been equally successful and pose difficult control problems, their habit of discarding their oothecae or egg cases meaning that whilst adults may be killed by insecticide treatments young nymphal stages may emerge later from the oothecae when the treated surfaces pose them little hazard.

Avon's local authorities have carried out many treatments over the years against various parasitic insects which cause problems inside buildings, such as fleas, particularly cat fleas (**Ctenocephalides felis**) and bed bugs (**Cimex lectularius**), whilst health workers have waged war in schools against the head louse (**Pediculus capitis**). George (1956) reported on fleas found in Gloucestershire, which at that time included the northern part of what is now Avon.

PARTIAL DEPENDENCE ON BUILDINGS

The common, brown, or Norway rat (**Rattus norvegicus**) is particularly associated with buildings but does also thrive in outdoor situations. It has been the subject of much publicity in recent times. The common rat was suspected of being implicated in problems with Weil's disease (Leptospirosis) in the Bristol dock area and there was much debate in the press over problems with "super" rats in sewer systems in Bristol and in other parts of Avon, particularly over the funding needed to carry out control.

PLATE 2 Scanning electron micrograph of the Flour Mite (**Acarus siro**).

Much more obvious relationships are apparent between some bird species and Man's buildings. However only two birds, the feral pigeon and the house sparrow (**Passer domesticus**) are species which are likely to remain in Avon's urban areas for most of their lives. Flocks of pigeons in urban centres bring pleasure to many who enjoy feeding them but one such enthusiast, who was becoming exhausted by putting out in her garden 20 lbs of grain per day for pigeons, sought advice on what to do to meet this ever-growing demand. It was explained to her that pigeon numbers in any flock are regulated by the amount of food available to them and that if she halved the amount she would soon see only half the number of mouths to feed. The pleasure derived from pigeons by some is balanced by the annoyance felt by others who have to cope with the mess from droppings, blocked gutters and the disease hazards they represent in food and animal feed production units. Feral pigeons and house sparrows both nest in and on buildings, the latter species being a particular problem in premises such as bakeries.

Insects which are commonly encountered inside buildings include the wasps (**Vespula** spp.), the garden ant (**Lasius niger**) and various fly species such as the house fly (**Musca domestica**), bluebottles and greenbottles (Calliphoridae). All these are species which enter buildings looking for food, either to "take away" as in the case of the wasps or in which to lay eggs as is the case with the flies. However, cluster flies, such as **Dasyphora** spp., **Pollenia** spp. and **Thaumatomyia** spp., frequently cause concern by entering buildings in large numbers in the autumn especially. These species do so to find places to overwinter and, whilst small numbers might be tolerated in a roof space, the discovery of thousands often causes alarm and indeed in a few cases the clusters have set off alarms! House sparrows and bats are other species which regularly trigger alarm systems inside buildings.

OTHER URBAN DWELLERS

Other wildlife species in Avon which may cause problems include those to which buildings and man-made structures are, on the whole, incidental. Foxes (**Vulpes vulpes**) living in the City of Bristol rear litters under sheds in gardens and occasionally under the floors of houses, having gained access through damaged air-bricks. Badgers (**Meles meles**) develop sets in gardens, sometimes because houses have been built very close to existing setts and the badgers have stayed. Developers at Stoke Bishop in Bristol deliberately protected an existing sett and built around it, proclaiming its existence as a positive feature for prospective purchasers, who might however be well advised to bear in mind that there have been occasions when badgers have extended their setts under buildings, using the foundation as a roof to the tunnel. Harris (1984) reported the presence of 346 badger setts in an area of 129.4 km^2 in the City of Bristol. Rabbits (**Oryctolagus cuniculus**) visit some urban gardens and even moles (**Talpa europaea**) have turned up in some most unexpected concrete locations.

Starlings (**Sturnus vulgaris**) make use of urban Avon structures particularly in their pre-roost assemblages and for overnight roosting. An enormous roost at Temple Meads station in Bristol is a well-known example of an overnight roost,

PLATE 3 Herring Gull nest on rooftop.

but the birds are not always welcome at some of their gathering points such as some of the city's churches. However, the aerial manoeuvres of the flocks at dusk are a marvellous spectacle and bring joy to many. Collared doves (**Streptopelia decaocto**) have become established in many urban situations, often feeding in buildings such as grain-handling premises but, unlike the feral pigeon, nesting in trees. Collared doves and woodpigeons (**Colomba palumbus**) give rise to complaints about damage caused to garden crops and, in the former case, about their incessant monotonous call! The relatively recent practice of herring gull (**Larus argentatus**) and lesser black-backed gulls (**L. fuscus**) nesting on buildings (Plate 3), especially in the centre of Bristol, was considered as a novelty early on but is considered to be a nuisance by those whose sleep is disturbed throughout the night by alarm calls, and those who are hit by faeces and are harassed by diving gulls seeking to protect their chicks. Gulls are amongst the species which feed on Man's waste food, particularly at the county's refuse tips, where they are possibly important in disease transmission to farm livestock. The avoidance of bird strike hazards near airports is an important factor to be considered when new dumping sites are planned.

The tolerance by most people of some invertebrate groups is surprisingly low. Woodlice (Isopoda), spiders (Aranaea), earwigs (**Forficula auricularia**) and other crawling animals cause revulsion with some people who go to desperate lengths to stop up any gaps around skirting boards and ventilators, to deny them access to their rooms. The seasonal appearances of adult cockchafers (**Melolontha melolontha**) which crash into windows at night, carpet beetles (**Anthrenus verbasci**), fur beetles (**Attagenus pellio**) and wasps (**Vespula** spp.) always spark requests for information.

PEST PROBLEMS

The welcome given to wildlife in urban Avon depends on the species, where it is and its impact or intrusion on Man's way of life. A naturalist may enthuse about feeding eight or more badgers in his or her garden every night, but the neighbour who is a keen gardener or green-keeper who finds the lawn scratched up by the same animals will have very different views of their acceptability in the urban environment. Most problems about which advice is sought tend to be related to such 'nuisance' situations, although the potentially serious nature of damage or disease is often of real concern to enquirers until ADAS advisors are able to reassure them, which they are often able to do.

Damage caused by feeding activities, such as by foxes or badgers digging in lawns or taking strawberry crops, is usually of little economic significance. Rabbits invading from adjoining countryside however, do frequently seriously graze allotment and garden crops and are a source of discord between neighbours. This sometimes leads to a formal complaint to MAFF, which could result in statutory enforcement action being taken under the Pests Act 1954, although the aim is normally to find a practical solution which does not lead to the issue of an order. Predation of a pet rabbit or guinea-pig causes emotional upset and sometimes more significant losses when show-quality animals are involved.

The excavation by badgers of a 30 cm diameter tunnel system under a house or garage can lead to real structural damage; the significance of such problems was discussed by Symes (1989). Excavations by rats, particularly in sewer systems, can lead to serious damage to underground services and is one way that they commonly enter properties by gaining access to cavity walls. However, it is the possibility of potentially fatal diseases, such as Weil's disease and salmonellosis, being spread by rats and mice, and in the case of rats of children being bitten, that spurs people to seek control action. The Council issued a leaflet warning users of Bristol City Docks of the dangers of Weil's disease, a Bristol man having died of the disease in 1989.

The discovery of a stored product insect in a retail pack of food is clearly unacceptable and such a case frequently results in a prosecution being brought by Environmental Health Officers. Whilst few of the stored product pests have been implicated in disease transmission, many of the hygiene pests such as cockroaches, flies and Pharoah's ants have been shown to carry various bacteria and their control is clearly desirable.

Excreta from mammals and birds is a frequent source of complaint. Animal feed producers and bakers are most concerned to prevent feral pigeon or house sparrow faeces contaminating their products, both from the aesthetic point of view and because of the clear risk of disease transmission. The presence of house mouse droppings on every surface of a fish and chip shop recently resulted in fines of £3,700. In gardens badger faeces accumulate in pits and can cause offence to householders and arouse concern of possible disease transmission to small children. In favoured public places the feeding of feral pigeons inevitably results in nearby buildings becoming 'decorated' with excreta. The extent to which this can become a serious problem is illustrated in London where the Westminster Council reportedly spends some £20,000 per annum clearing pigeon faeces from Trafalgar Square; 50 tons of such material was removed from the nearby Home Office roof. Starling roosts on buildings and on trees often result in considerable accumulations of material underneath (Plate 4), presenting important hazards to the public.

The Times (9 October 1989) reported that a "seagull" which landed on a circuit breaker in a 33,000 volt electricity substation caused around a quarter of Bristol to be without power for over an hour.

MAN versus WILDLIFE

Where the presence of wildlife in some homes and gardens, in offices and

PLATE 4 Accumulated Starling faeces under tree.

other public and industrial locations in Avon is unwelcome, considerable effort and resources are spent on methods of prevention of the problems or on control. Local authorities and universities in Avon and the Wildlife and Storage Biology department of MAFF all become involved in offering advice, although the role of the latter is mainly in offering advice and training to local authority and pest control contractor staffs. Control services are offered by local authority Environmental Health departments for some problems, but the main professional pest control services are those offered by some 30 or so contractors who work in Avon at present. These vary from large national or international companies to smaller one-man organisations. Water authorities own the sewer systems and may carry out rat control themselves or employ local authorities or contractors to do so. Bristol Evening Post (March 1989) reported that Wessex Water Authority had doubled to £40,000 the usual allocation to be spent on control of sewer rats. This was in response to collapses of sewers attributed to rat activity. In the case of problems caused by individual species, help may be available from voluntary groups, such as the Avon Badger Group.

The techniques which may be employed to alleviate pest problems are controlled by legislation which affords special protection to wildlife (e.g. Wildlife & Countryside Act, 1981); restricts techniques which may be used against wildlife (e.g. Badgers Act, 1973); lists chemical substances which may be employed (e.g. Control of Pesticides Regulations, 1986); insists on the safety of methods (e.g. firearms legislation) and demands humaneness (e.g. Protection of Anumals Acts, 1911-27).

To prevent damage or nuisances by mammals and bird species often calls for considerable ingenuity. Techniques employed range from elastic straps to hold dustbin lids in place, electrified fencing (Plate 5) incorporating badger gates, to a multitude of anti-perching devices (both commercial and home-made) which are used to prevent birds perching on structures and a multitude of designs of traps. Examples of anti-perching devices may be seen on the City Museum and Art Gallery and of the extensive use of netting to deter starlings on St. Mary Redcliffe Church in Bristol. Chemicals used against birds are taste repellents such as aluminium ammonium sulphate and, under licence from MAFF, alpha-chloralose and seconal which are used to stupefy feral pigeons and house sparrows only. Repellents such as bone oil have been used against some mammals but the legal situation over the use of some compounds is being resolved (Symes, 1985).

The chemicals which are commonly used against rodents are the first generation anti-coagulant rodenticides such as warfarin, coumatetralyl and chlorophacinone, and the newer second generation anti-coagulants such as brodifacoum, difenacoum and bromadialone. House mice are generally regarded as resistant to the first generation multiple dose compounds and are controlled by calciferol and alpha-chloralose particularly. In Avon there is no known resistance to the anti-coagulant rodenticides in rats, but a current research project by MAFF's Wildlife and Storage Biology department is randomly sampling rat populations in Avon and surrounding counties looking for resistance which is known to be present in Wiltshire.

Substances to control insect problems line the shelves of chemists' and hardware shops and of garden centres. These chemicals and those which are available to pest control contractors in Avon under the Control of Pesticides Regulations, 1986, include the inorganic boric acid, natural pyrethrums, synthetic pyrethroids such as tetramethrin and deltamethrin, the organo-chlorine compound lindane, various organo-phosphorus insecticides such as fenitrothion, carbamates e.g. carbaryl, and recent innovations such as the insect growth regulator metho-

PLATE 5 Badger sett in garden, surrounded by electrified fencing.

prene. Whilst this formidable array of pesticides is ever-changing in response to consumer demands and to problems such as resistance, the possible hazards to non-target wildlife species are assessed in increasingly sophisticated ways in the development and screening processes which are required before any new compound is allowed onto the market.

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THE BIRDLIFE OF BRISTOL

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ABSTRACT

We outline the considerations that govern the bird species to be found regularly in the administrative City of Bristol. We then describe the origin and nature of the complex series of habitats present and the ways in which birds use them, with special attention to the winter season. We consider the role played by the city in the life of its birds and conclude that very few species can be confidently claimed to depend entirely on the city throughout their lives.

INTRODUCTION

Modern Bristol is much larger and more complex than it was a hundred or even fifty years ago (see Figure 1a), and some of the birds using it are present only because the administrative boundary now encloses large areas that are distinctly rural in character. Paying homage to the urban theme of the present publication, we considered excluding these rural areas, but we could find no ecologically based criterion of selection that seemed either generally accepted or easily applicable to Bristol. For example, the ornithologist Strawinski (1963) defined an urban area as one with over 400 humans per square kilometre, but Tomialojc (1970), working on town and village bird communities in Lower Silesia, found this criterion unsuitable and suggested a conventional limit based on the total size of the human community, say over 5,000 persons. We return to this topic later but for most of our account we decided to follow the practice of authors such as Luniak (1983), Wink (1986) and Witt (1986), and to take the entire administrative city as our subject, though where possible we comment specifically on the urban core. We refer only occasionally to the historical changes in Bristol's bird community, but we sketch the history of the habitats so as to provide an understanding of the present situation.

Most of the survey work done on Bristol's birds in the past 25 years has been based on the National Grid and so, for convenience, we have included the whole of any one-km grid square that contains an appreciable area inside the city boundary. "Squared up" in this way the city covers 126 one-km squares and these form the area we discuss.

DEFINITIONS

For brevity we have used a few technical terms with specific meanings:

Anthropogenic: produced by human activity. **Anthropogenic change:** any change in the local environment resulting from human actions, for example the original forest clearances, the development of agriculture, the rise of cities, water-borne sewage systems, atmospheric pollution, domestic heating that does not need chimneys and building techniques that exclude birds from roof-spaces.

Synanthropy: the habit of wild creatures of living alongside man, making use of his fields, gardens and buildings.

Urbanisation: adaptation to life completely within an urban environment, with no dependence on or use of the rural surroundings.

THE BASIC INFLUENCES

There are three main influences that determine the species and numbers of birds using an urban area. The first is the composition of the bird population in the surrounding region, which is determined by external or **biogeographical** factors, like the geographical location, the altitude, the climate and the general nature of the surroundings (a large body of water nearby, for example). Secondly, some of these species are ruled out as urban colonists through having special **habitat requirements** or **behavioural constraints** which the city cannot satisfy. Conversely, in some cases behavioural changes may develop which allow access to urban niches. Thirdly, for the remaining species - the potential colonists - the **structural features** of the city determine which species do actually move into it, how far they penetrate and how they use it in different seasons. These features include the size and shape of the built-up area, the nature and distribution of the habitats present and the existence of "corridors" of open ground, woodland or water linking its interior with its surroundings, features that are interdependent and often strongly linked to the city's age and history. We now consider these basic influences as they apply to Bristol.

BIOGEOGRAPHY

The first perspective to establish is that fewer bird species regularly breed in Britain than on the nearby mainland, and fewer in the west of this country than in the east, a consequence of the well-known "island effect" (see, for example, Macarthur & Wilson, 1967) together with Britain's position on the west of the Eurasian landmass and thus at or beyond the fringe of the range of many species. So, for example, Tawny Pipits and Crested Tits are available to live in Berlin but not in Bristol. On the other hand, we have access to species linked to the coast, so that Shelduck and Herring Gulls breed near Bristol but not near Berlin. Within Britain our situation on a south-western peninsula surrounded by seawater warmed by the North Atlantic Drift (the Gulf Stream to many) gives the region a generally mild climate. This makes it suitable for breeding by many species, including some - like Reed Warbler and Nuthatch - that have a limited distribution nationally; while in hard winters it can serve as a refuge for birds fleeing continental cold. Accordingly, local bird numbers are much increased at the relevant seasons. As to birds occurring only on migration, it is true that fewer species and fewer birds pass on the western than on the eastern coast of Britain, but passage migrants play no role in what follows.

BEHAVIOURAL AND HABITAT LIMITATIONS

Many species using the ground and shrub layers of the rural area cannot tolerate disturbance and move out when an urban settlement starts to develop. These include the game birds (Pheasant and Partridge); Skylark (which, being a steppe species in origin, will not tolerate cover above the field layer); pipits,

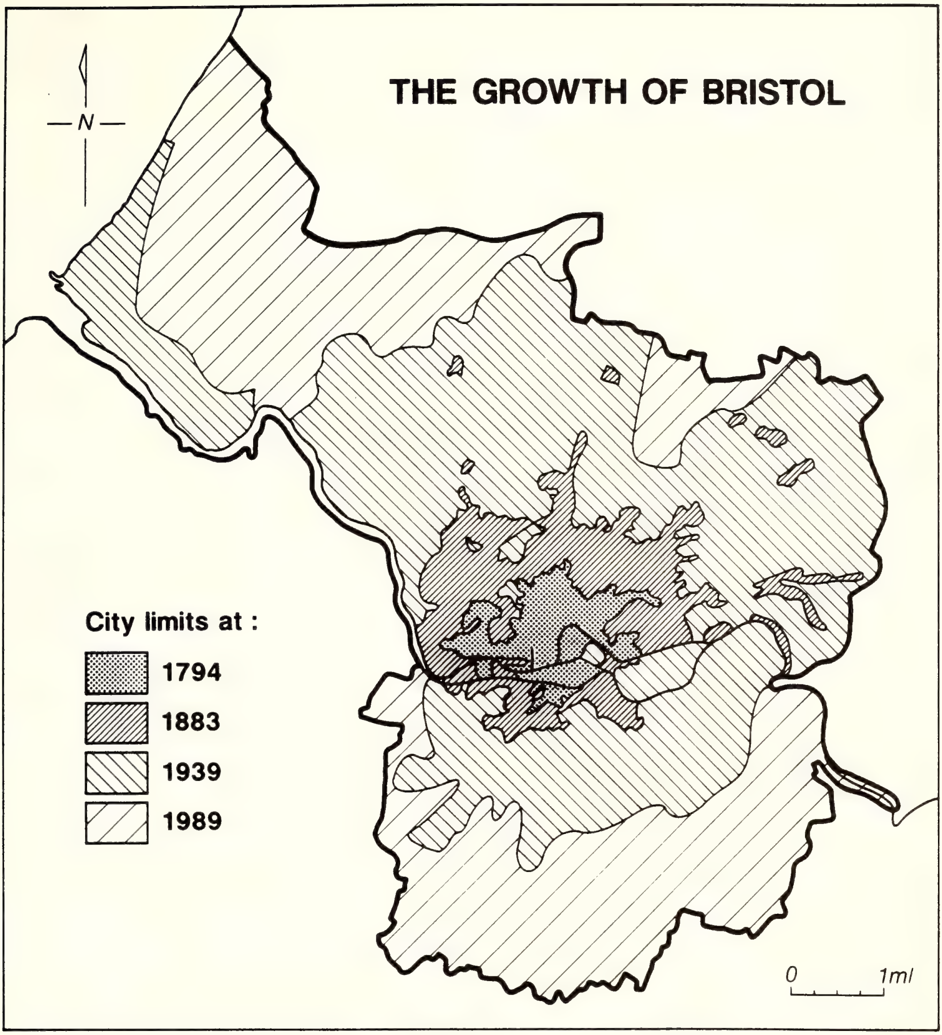

FIGURE 1a Showing the growth of Bristol from the end of the eighteenth century to the present day.

Garden and Wood Warblers and buntings; and birds of water and wetland habitats, like Mallard, Coot, Moorhen and Yellow Wagtail. These birds withdraw to the surroundings of the urban area. Later, as the city grows, suitable habitat may be created within its boundaries to which some of the exiles can return, like Eastville and St George Parks, whose lakes hold small but thriving populations of wildfowl and waterfowl. Also, expansion of the administrative area may bring within it islands of farmland or woodland which will retain their bird populations until disturbance becomes excessive.

In contrast, most of the tree-canopy dwellers manage to come to terms with urban life. Even Rooks, nesting in the canopy but feeding on the ground, may stay faithful to a traditional rookery long after urban development has forced a lengthy flight to new feeding grounds. Eight or so nests in plane trees in Queen Square survived for many years until some time between 1950 and 1955 and solitary pairs bred there occasionally later; another rookery on Brislington Hill with some two dozen nests in elms dated from at least as early as 1915 (when it was in the country) and stayed in use while development spread up to it between the wars and well beyond it in the 1950s (Taylor, 1957), disappearing only when the trees were removed in the 1960s. However, some tree-nesting species, like Buzzard, cannot accept the disturbance inherent in urban life even if pockets of woodland remain available to them.

Other species of the region may find no suitable breeding or feeding site within the city, or may do so only following some behavioural adaptation. Thus Shelduck are present in the area but not in the city, and Herring Gulls have fed in the city along the river Avon probably for centuries, but did not breed there. The habit by the larger gulls of nesting on city roofs was scarcely known in 1940 but has steadily spread since then (Monahan & Coulson, 1977) and reached Bristol in about 1970.

THE STRUCTURE OF THE CITY

The third and last group of factors are those concerned with the detailed structure of the city. Bristol, like most large cities, abounds in open areas and natural cover in the form of parks, cemeteries, playing fields, bowling greens, private gardens, allotments, a few disused quarries and claypits, and recently, shrubberies on some large roundabouts. Suburbs with mature gardens are structurally akin to open woodland scrub with frequent vertical cliffs and occasional small ponds. Trees lining streets and in pedestrian precincts are feeding sites and roosts as well as marking avian flyways. Obviously all these features will be fewer and less significant in smaller towns, where communal open areas are often near to or on the periphery and are in effect part of the rural surroundings. Simms (1975) gives a detailed account of the history of suburban habitats. Large size has another effect: the "urban heat island" in the heart of a large city is a welcome resource to birds in winter or in a cold, damp spring.

The city's historical development is important for at least six reasons. First, like many towns of medieval or earlier origin Bristol grew up at a key point - at the confluence of the Rivers Avon and Frome. With later growth the waterways remained as access corridors for birds and also for the small mammals and invertebrates which form their diet. During the late eighteenth century these natural corridors were supplemented by canals, from the mid-nineteenth by railways and from the mid-twentieth by expressway verges.

Second, Bristol's history has determined its shape. From its initially compact and circular form, its growth has been constrained in some directions and drawn out in others. The rivers, especially the Avon in its Gorge, along with the marshes in the valley floors, were a heavy constraint on occupation, often reinforced by preservation in the hands of big landowners. In other directions there was rapid growth, notably along its trading links towards Bath in the east and Gloucester in the north, and villages in these directions were absorbed into the urban fabric. Development spread into the green areas between the main roads, but it was not until the 1930s to 1960s that council housing estates began to fill in the urban form, especially to the neglected south of the Avon (Figure 1b). Even now substantial green wedges remain (Purdown is still the best example), and in consequence some of the satellite suburbs along the main radial roads display

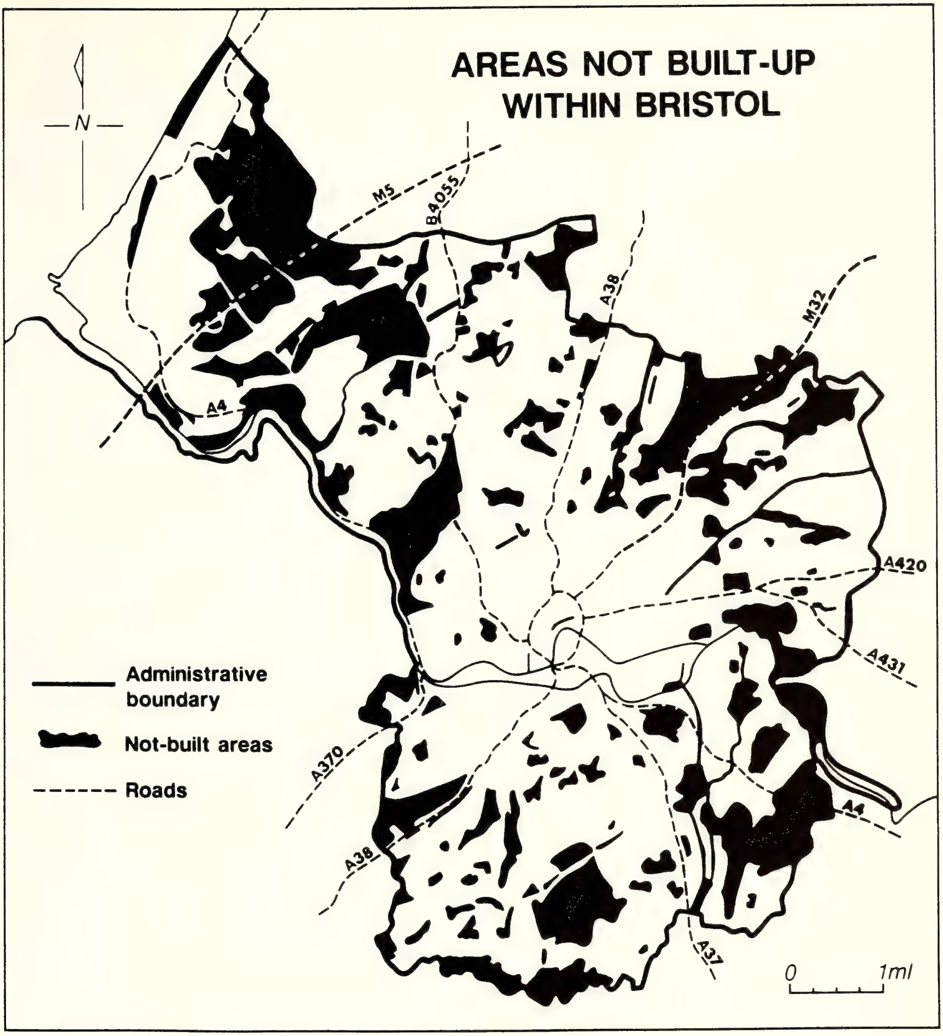
AREAS NOT BUILT-UP
WITHIN BRISTOL
N
M5
B4055
A38
M32
A4
A420
A431
Administrative boundary
Not-built areas
Roads
A370
A38
A4
A37
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FIGURE 1b Showing areas not built-up within the City of Bristol.

structural characters of small towns. Infill development before the Green Belt legislation of the early post-war period led to the consolidation of the city, but a surprising amount of open land remained in the form of municipal parkland, recreation grounds, school playing fields, and 'dead ground' alongside railways and rivers. Since 1947 town planning acts have restricted over-zealous infill, and major urban development has tended to be concentrated in peripheral towns like Yate/Chipping Sodbury, Nailsea, North Filton and so on, reducing pressure on the surviving urban open areas.

Third, especially in the eighteenth and nineteenth centuries, well-to-do inhabitants built houses at the edge of the town, often on the up-wind side, with ample gardens and taking advantage of hills to obtain country views. As urban growth engulfed these the process was repeated further and further out. At each stage parts of the original gardens would remain, either in private or in public ownership, as garden, parkland or woodland usually with mature trees. In the 1960s and early 1970s the Conservation Committee of Bristol Naturalists' Society successfully pleaded for the relief of development pressure on some of these areas (Gravestock, 1986).

Fourth, since the start of the nineteenth-century industrial revolution, there have been cycles of industrial growth, change and decline which have left temporary pockets of waste or derelict ground where ruderal vegetation could support a few seed-eating birds. On the other hand large areas were filled with low-grade terraced houses to accomodate the industrial workers who flocked to the town. These areas had little amenity; they were at that time, and their residue is still today, almost devoid of significance for birdlife. Some have been cleared and now hold tower blocks with much more open ground, often partly grassed, but it is doubtful whether these changes have increased the numbers of birds using these areas, which are largely House Sparrows. These form a truly urbanised population, probably based on survivors of the most dramatic urban anthropogenic change of this century - the replacement of horses by the internal combustion engine, with the consequent annual loss of hundreds of tons of bird food in the form of horse manure and spilt grain and chaff.

Fifth, like other cities with a long history, Bristol had a core of old, narrow streets of richly-ornamented buildings, some of which survived the war-time bombs of the early 1940s. To birds these are a network of steep-sided valleys, able to ameliorate winter winds, and lined with an ample supply of crevices and ledges to provide sheltered roost sites. What a vivid contrast this makes to the wider streets and plainer structures of the suburbs. Here the newer methods of construction, with close-fitting soffit and gutter boards, deny Swifts and House Sparrows access to roof spaces, and are often made of "maintenance-free" materials to which House Martin's nests will not adhere.

Finally, as in other ancient trading centres, the warehouses around the docks became the home of a concentrated rodent population which attracted, and still attracts, avian predators. Surviving warehouses still occasionally house breeding Kestrels.

The effect of all these features has been to create an exceedingly varied mosaic of habitats. Below, after listing the sources of our data, we summarise the main habitat types and the salient features of their use by birds, with special consideration of the city in winter.

SOURCES

The discussion of the major habitat types and their use in the next section is based on material from the following sources, to which reference should be made for further details. These cover essentially all the organised studies made on Bristol birds over the last three decades.

(a) A study of Bristol birds, made by RLB between 1967 and 1977, on the basis of presence or absence in one-km squares. It covered the entire administrative City of Bristol, enlarged to include the whole of any one-km square containing an appreciable part of the city, so giving a total of 126 squares. In 1977 an examination of the major habitats was made, and this is the basis of the figures for habitat extent given below. A 60-page mimeographed report on this study had a limited distribution; lack of resources prevented wider publication. Since 1977, development has eroded the open grassland and farmland on the edge of the city, and increased the suburban area and (slightly) the heavily built-up area. Waste land has been both lost and gained. All in all, it is doubtful whether any of the values given have changed by more than 1% (since 1% of the city is about 1.26 square kilometres).

(b) Recent accounts of bird life in particular areas of Bristol, published in the Proceedings of the Bristol Naturalists' Society or in Bristol Ornithology. Subjects include Old Bristol Airport (Vinicombe, 1970), the Frome Valley (Gravestock, 1976), the Avonmouth Sewage Works (Gray, 1979), Blaise Woods (Tully, 1984), the tidal Avon (Rose, 1987) and Clifton Down (Bland, 1987).

(c) Studies of particular species in all or much of the city, e.g. Kestrels, and Rooks and Magpies (Bland, 1982).

(d) Two co-operative projects which have surveyed the distribution of birds in Avon county in winter and in the breeding season, on the basis of tetrads or two km x two km squares (see Bland, 1985, 1987); both covered the whole of Bristol.

(e) A continuing study, started in 1974, of overwintering Blackcaps (Bland, 1986) through the medium of an appeal for sight records in Avon county; the great majority of the reports come from Bristol.

(f) A long-term co-operative survey of birds using Avon gardens in winter; more than half the sample gardens have always been in Bristol. The results have not yet been published in full but occasional summaries have appeared in the Avon Bird Report. They are important in considering the role of urban areas in bird life, and are drawn upon for the appropriate section below.

(g) Data from the Bristol Bird Report up to 1973 and its successor the Avon Bird Report from 1974 (both published annually in the Society's Proceedings until 1978, since when the Avon Report has been a separate publication). These reports include the results of occasional surveys of Mute Swans and Rooks.

THE MAJOR HABITATS

These are dealt with in decreasing order of their estimated area in 1977.

(1) The most extensive type is **suburban houses with gardens**, making up some 49% of the city. Its value to birds varies greatly, depending largely on the amount of tree and shrub planting. At worst, some areas support hardly any species except Starlings and House Sparrows. At the other extreme large and mature gardens may support a greater density of breeding birds and more species than some woodland (Bland, 1979). These are not only resident species, but summer migrants too - SMT recorded both Redstart and Chiffchaff in Redland in the early 1950s - and not only the smaller species but residents as large as Woodpigeon, Collared Dove and Tawny Owl. Although breeding density can be high, productivity may be depressed through shortage of invertebrates needed by nestlings (even those of seed-eating species) in their crucial first days (Cowie, 1987). Another drawback is predation, largely by the high urban population of cats (Churcher, 1987), but to some extent by magpies and Carrion Crows. However an analysis of the nest record data held by the British Trust for Ornithology (BTO) indicated predation rates to be lower in suburban areas than on farmland, and to be highest in woodland (O'Connor & Shrubb, 1986).

(2) The **heavily built-up** areas, with shops, offices and industry amount to some 13% of the whole. [Waste land which often accompanies industrial growth and decline is dealt with at (5) below]. This too is a very varied category, usually with little or no vegetated open space. Bird density and variety are lowest here;

Feral Pigeons and House Sparrows are the main breeding species, but Herring and Lesser Black-backed Gulls, to the extent of 300 or more pairs, have found flat roofs to be safe and practical nest sites in central Bristol (Rock, 1983). Kestrels have used sites such as bombed warehouses and a gas works, as well as the University Tower (Bland, 1982). Other species are not slow to occupy available niches - opportunism seems to be a trait of urbanised birds, perhaps encouraged by their having become accustomed to living close to humans. As examples, Blackbirds reared young in the tea garden on the roof of a department store in the Horsefair, using plastic scraps as nest material; and Feral Pigeons nested on an air-conditioning duct in a factory at Ashton, gaining access via a missing window pane and building their nest from nails and wire fragments collected in the factory yard.

(3) **Parks, bowling greens, cemeteries and allotments**, another very varied class, amount to 10%. The old and overgrown cemetery at Arno's Vale is one of the most useful; allotments, because of intensity of human use, are the least - although abandoned, weed-covered plots are valuable food sources for seed-eating birds such as finches, and may carry insects and mice and thus be of use to other species. The city is well supplied with parks and, though some are of necessity kept close-mown, most have mature trees. The larger areas, managed sensitively by the City's Parks Department, have remarkable bird populations; a good example is Oldbury Court Estate, which includes part of the valley of the River Frome (Gravestock, 1976). Typical species are those of the tree canopy, including Blue, Great, Coal, Marsh and Long-tailed Tits, Treecreeper, Nuthatch, Green and Great Spotted Woodpeckers and Jay; birds using the Frome, including Mute Swan, Mallard, Moorhen, Kingfisher, Dipper and Grey Wagtail; raptors, including nesting Kestrel, Tawny Owl and Sparrowhawk; and the common warblers and finches.

(4) **Open pure grass habitats**: playing fields and golf courses, usually close-mown. Amounting to 9% in 1977, this class may have fallen by now to 8% through subsequent losses to development. Unless they have hedges they offer nothing in the way of nesting habitat, being far too disturbed to be used by Skylarks. However they are often a source of food for Blackbirds, Song and Mistle Thrushes and Starlings in the breeding season, and in winter can sustain birds as diverse as Black-headed Gulls, Feral Pigeons, Redwings, Jackdaws and Carrion Crows.

(5) **Waste land** amounted in 1977 to 8%. We include here the verges of motorways and access roads, normally undisturbed by humans, which provide resources of seeds, invertebrates and - for Sparrowhawks, Kestrels and Tawny Owls - small birds and mammals; Kestrels are often conspicuous as they hunt along the verges of the M32 urban motorway. Waste areas formed on the abandonment of a railway line or yard, or the closing down of an industrial undertaking, may exist only temporarily. The closure of St Anne's Board Mill in 1980 added a substantial area, though urban renewal projects on a massive scale are planned here for the 1990s. Municipal rubbish tips, established on some waste areas, are concentrated sources of food: a long-lived tip at Stockwood, on which many city birds - notably Gulls and Carrion Crows - used to scavenge, was closed at the end of January 1989. Filled tips are reclaimed, grassed and planted with trees, as on Bedminster Down; they tend to be immune from residential development and to become permanent additions to the parkland area of the city. Because many waste areas are not managed in any way, their vegetation often develops rapidly into scrub and they can become wildlife havens. Such areas do not have specific bird species associated with them, but their existence throughout the urban area

provides food sources which may be vital to some species.

(6) **Farmland**, in use or abandoned, formed some 6% of the city, mainly on the outskirts - e.g. the northern slope of Dundry Hill and areas inland from the Severnside industrial estate. For some areas, such as Stoke Park, allocation as abandoned farmland, parkland or waste land is admittedly somewhat arbitrary. Urban farmland can be more valuable for birds than farmland outside the city, both because farming operations tend to be less intensive and because few or no pesticides, fungicides and herbicides are used. In the last twenty years or so these chemicals have reduced the diversity of wildlife in many rural areas; one consequence is the loss of weed seeds which is believed to underlie the decline of certain finch species (O'Connor & Shrubb, 1986). Such land still supports Skylark, Pheasant, Lapwing until its recent general decline, Stock Dove, Little Owl, Stonechat until its local decline in the later 1970s, Whitethroat and Lesser Whitethroat and Yellowhammer. Few of these species would have found a place in the smaller city of 1900.

(7) **Woodlands:** some 38 distinct woods together form 1% of the city's area. Collectively they ensure that all the usual woodland birds, including all three woodpecker species, Nuthatch, Treecreeper and the common woodland warblers breed within the city. Some of these woods are part of larger parkland areas, while others are hemmed in by other types of habitat and survive by some quirk of ownership.

Sparrowhawk	0.8	Blackcap	7.0	Nuthatch	2.6
Stock Dove	5.3	Wood Warbler	0.1	Treecreeper	1.5
Woodpigeon	9.6	Chiffchaff	5.6	Jay	2.8
Tawny Owl	0.3	Willow Warbler	0.1	Magpie	1.5
Green Woodpecker	2.1	Goldcrest	3.3	Jackdaw	5.6
Great Spotted Woodpecker	1.1	Spotted Flycatcher	0.1	Carrion Crow	0.3
Wren	19.0	Long-tailed Tit	1.1	Starling	12.1
Dunnock	3.8	Marsh Tit	0.6	Chaffinch	3.6
Robin	14.8	Coal Tit	3.0	Greenfinch	0.5
Blackbird	24.3	Blue Tit	31.3	Bullfinch	0.6
Song Thrush	3.0	Great Tit	13.0	Mistle Thrush	1.1

TABLE 1 Average number of territories (breeding pairs), 1979-84 in the eight hectares of Blaise Woods Common Birds Census plot. (Taken from Tully, 1984).

Some of the city's woods are mere fragments that might appear unimportant, but recent work elsewhere suggests that they should not be dismissed lightly. A study of 25 woods in the new town of Milton Keynes (Taylor **et al.**, 1987) found that the density of breeding birds rose steeply as wood size decreased, and averaged 41 territories per hectare in the smallest woods (0.25 to 0.8 ha), over three times the density in woods of 20 ha or larger, though the small woods held far fewer species.

In contrast, other woodland is clearly important - a good example is that on the Blaise Castle Estate, another instance of excellent municipal management. Since 1979 an area of 8 ha of Blaise Woods has been studied during each breeding season by J. Tully as one of the sample plots in the BTO's woodland Common Birds Census (Taylor, 1983). Table 1, given by Tully (1984), lists the breeding species and their average number of territories in the first six years and demonstrates the richness of the birdlife.

This gives an overall density of 22.7 pairs per hectare, about twice that in Milton Keynes woods of comparable size, and far above the figure of 6.2 quoted by Sims (1971) for normal mixed woodland, though far below the 35.2 found by Parsons (1976) in a mixed woodland in Somerset.

(8) **Water.** Bristol is fortunate to have a remarkable variety of water bodies, including a stretch of the Severn shore, the tidal and non-tidal Avon, the Floating Harbour, New Cut, Feeder Canal, the Avonmouth and City Docks, a number of small lakes and ponds, and two rapid streams - the Frome and Trym - in steep-sided gorges. Water habitats account for about 2% of the total area. Though most of the streams are polluted to some degree, Kingfishers and Dippers breed on the Frome and Trym and the lakes produce an annual crop of cygnets, ducklings and Moorhens. Coot, which formerly bred only on ponds at Avonmouth, have become established in recent years on Eastville Park Lake, where the number of Moorhens has subsequently declined; Mute Swans and Mallard still breed there. The quality of the River Avon's water has markedly improved since the new trunk sewers and the Avonmouth Sewage Treatment Works came progressively into use from the mid-1960s, replacing more than fifty sewers that formerly discharged into the River Avon within the city, but a review of the available evidence does not suggest any great change in the numbers of birds feeding on the river (Gray, 1986). However, Kingfishers were seen to catch fish near Bristol Bridge in the autumns of 1987 and 1988.

(9) Two other types deserve mention, though they cover only small areas. Bristol is exceptionally well endowed with **cliffs.** These provide nest sites for Kestrels and Jackdaws, as in the Avon Gorge (where a pair of Peregrine Falcons and a pair of Ravens also bred in the inter-war period). They become clothed in trees and other vegetation which, because of the cliffs, are usually immune from disturbance and provide a safe breeding site for smaller birds.

Wetlands are now confined to the Lawrence Weston - Avonmouth area. In particular the 12.5 hectares of Lawrence Weston Moor nature reserve, owned by the City Council and managed by the Avon Wildlife Trust, consists in part of wet grazing meadows and reedbeds, with mature hedgerows and freshwater ditches. It has a very rich flora and invertebrate fauna (Gravestock, 1974) and is now the only area within the City boundary where there is a possibility of finding breeding Sedge Warblers and Reed Buntings. Ashton Marsh, a second small wetland where Snipe used to breed within the city, has recently been lost by reclamation via drainage and landfill (Taylor, 1987).

THE CITY AS A WINTER REFUGE

Waste heat energy makes the interior of a large town significantly warmer than the outskirts, especially during the winter (Lamb, 1982). This "urban heat island" effect is mainly produced in the inner suburbs and the heavily urbanised area. It is the likely reason why hundreds of Pied Wagtails and thousands of Starlings come daily in winter from a substantial area of countryside to roost in the centre of the city, the former in street-side trees and on roofs and the

Starlings mainly at Temple Meads Station and under Cattle Market Road railway bridge, but also on older buildings in the inner business area and in trees in the Broadmead area and occasionally elsewhere. The Temple Meads roost appears to have originated in the cold winters of the early 1960s.

In winter the open water areas in the heart of the city, comprised of the old dock basins, the Floating Harbour, the New Cut, the Feeder Canal and the River Avon itself, normally hold from forty to fifty Mute Swans, several hundred Mallard and often several Little Grebes. In cold snaps when the South Avon reservoirs freeze over, these city waters form a haven for waterfowl; species seen on them in recent wintry spells include Great Crested and Slavonian Grebes, Shelduck, Wigeon, Teal, Tufted Duck, Pochard, Red-breasted Merganser, Goosander and Ruddy Duck. These waters have lost much of the heat input they formerly received from effluent and sewage (Gray, 1986) and cooling water (Taylor, 1986), though so far they seem no less attractive in consequence.

Gardens are especially important to birds in winter, and their use is more complex than might appear at first sight. The year-round residents are regularly augmented by visitors, both of their own and other species, from surrounding areas. Bird-ringing studies show that some of these, such as tit species and over-

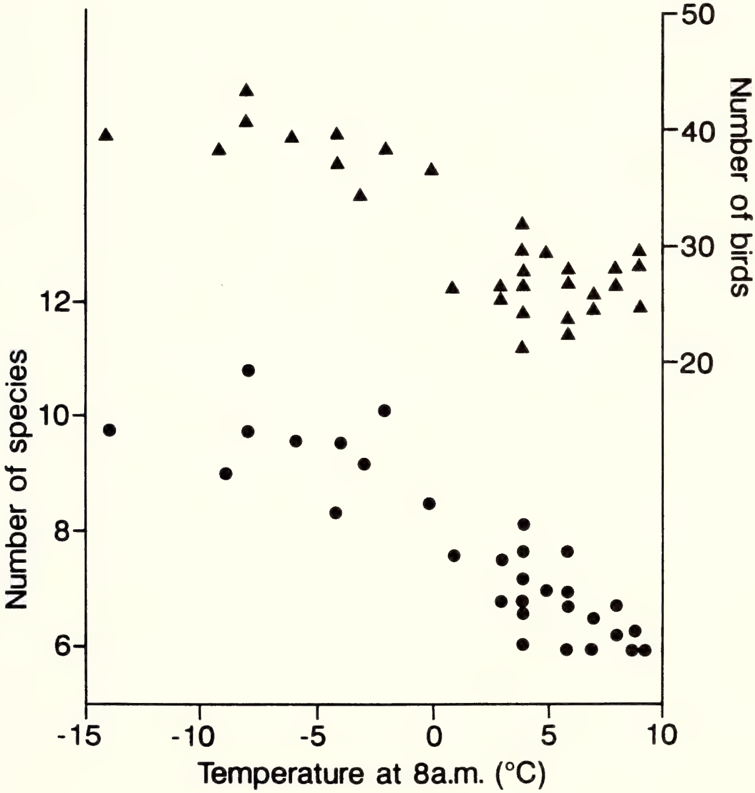

FIGURE 2 Daily Averages of Number of Birds and Number of Species present, for twelve gardens recording daily in January 1982, v. Temperature at 8 am.

wintering Blackcaps, often move about, so that though a garden may hold very few at any time, a considerable number may use it altogether. In the mid 1950s SMT ringed some fifty Blue Tits each winter in a suburban garden where it was rare to see more than seven at a time and H.R.H. Lance ringed ten male and eight female Blackcaps in his Stoke Bishop garden between late November 1979 and late February 1980, though no more than three were seen at once (Bland, 1983).

Normally, Bramblings and Siskins are rarely seen in urban gardens, but in years when large numbers irrupt they enter gardens in late winter, joining the commoner finches which moved in earlier. The total numbers of birds and the range of species visiting gardens both increase steadily as the temperature falls (Figure 2) and in the coldest weather immigrant Fieldfares and Redwings join the native thrushes in city gardens, where they are otherwise rarely seen. All these winter visitors to gardens are sustained by the natural food they find, and most also to a major extent by the provision of food on a large scale, often by people with no specialised interest in birds. Fieldfares and Redwings are reluctant to visit bird tables but readily feed on apples, whether fallen or still borne on trees. When a thaw comes, the less usual winter visitors will disappear with dramatic swiftness, a sign that they were present only under duress, and the numbers of the resident species also quickly fall back to normal levels (Figure 3).

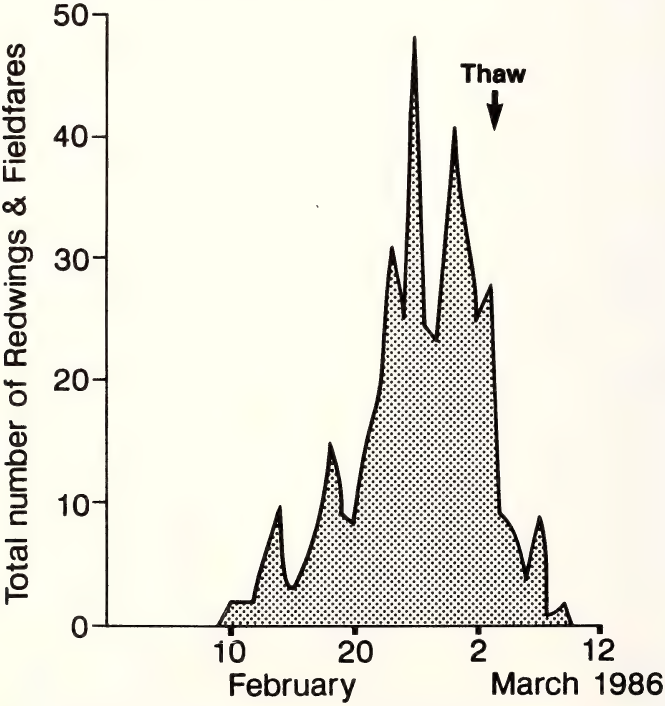

FIGURE 3 February 1986. Total Numbers of Redwings and Fieldfares in 18 gardens recording daily. Thaw, after six weeks continuous frost on March 4. Some Redwings were starving and unable to fly.

This reliance upon urban areas in cold spells for both shelter and food must ensure that larger numbers of some species survive than would otherwise be the case, and the overwintering by immigrant Blackcaps that has developed in the last twenty years (Bland, 1986) may well be dependent upon it.

ADAPTATION TO CITY LIFE

This is a convenient place at which to pause and review the question, on which opinions have differed, of the inter-relations of anthropogenic change, synanthropy and urbanisation. We take the view of Balogh (1958) and others that synanthropy follows anthropogenic change and is an adaptation by the birds to the use of humans' fields, gardens and buildings "because they are there" and independently of human assistance. Urbanisation, the culmination of synanthropy, is usually a later adaptation. The sequence may be envisaged as follows.

As the first settlements were formed in forest clearings some bird species would take advantage of the new habitats and food resources thus opened to them and, as settlements eventually grew into villages and then into towns, birds could adapt to nest in these too. All this is not supposition; it has been seen in twentieth-century USA (Udvardy, 1963, p. 364) and, for example, the European Swift originally bred in caves then adapted to the roofs of houses in forest clearings; its later adaptation to roofs in cities has been charted by Koskimies (1956). These are synanthropic relationships but not urbanisation; the birds still depend at least in part on rural food sources. Bristol's roof-spaces are just caves to the Swifts hawking insects over the distant reservoirs (Hammacott, 1985), and its flat roofs are only cliff ledges, albeit with some under-floor heating, to the Herring and Lesser Black-backed Gulls nesting on them (Rock, 1983). Urbanisation, complete dependence on the city, is much rarer and for nearly all species it requires a minimum size of city. Tomialojc (1970) stressed this point, noting that some species will only develop urbanised populations if there are parks (or the equivalent) in the central area, disconnected from the periphery.

Hinde (1970, p. 688) pointed out that learning plays a role in habitat selection in many species, so that selection of an abnormal habitat by some individuals may become perpetuated, providing scope for evolutionary adaptation to the new conditions. The winter influx of birds to the town could have been one mechanism by which urban breeding populations developed. Occasionally winter visitors not normally breeding in the city might have stayed to do so. Their young would then be likely to return to breed (Klopfer, 1963) and the process could continue.

Given suitable conditions (especially a nest site and a continuous supply of food) things could go further if young hatched in the city were able to spend their whole first year there. Knowing no other environment, they would breed there in turn and so form the nucleus of a new urbanised population. To the extent that a supplementary food supply, and perhaps the provision of nest boxes makes this process possible, it is probably the only deliberate human activity that could positively affect the process of urbanisation.

These adaptive processes can be comparatively rapid, as the case of the Black Redstart shows. From around 1840 this Mediterranean cliff-nesting species spread into central and western Europe (Mayr, 1926) and in time, still nesting on rocks, it reached the Carpathian foothills bordering the Hungarian plain. In the 1930s a few reached the plains city of Debrecen and nested on tall buildings in the central area, the sites most nearly resembling cliffs. They flourished and soon spread to nest in crevices on single-storey brick buildings in the suburbs, and finally even on wooden verandahs and sheds. This series of breeding-site adaptations gave the birds access to a habitat, wooded gardens, not available to them previously in which an urbanised population could develop (Udvardy, 1963).

As we pointed out in our introduction, we found no accepted ecological definition of whether a given area is urban in character, so we begged the question and took the entire administrative area as our subject. Returning to the truly urban theme, we ask now which species have urbanised populations. To qualify, a population of any organism should in our view be essentially, if not completely, isolated from its country fellows; if it is not, interchange may occur to an unknown extent, and the population may be partly relying on rural resources.

For birds we relax our definition somewhat, so as to include migrants that summer (or winter) entirely within the city. So we count as truly urbanised the warblers that spend their whole breeding season in one of the city's parks or woodlands even though much of their year is spent in another continent. We treat the Blackcaps wintering in the suburbs in the same way, since these are winter migrants from northern Europe (Langslow, 1979). But creatures using the city regularly, though for only part of the day, are not urbanised. By definition, an urbanised population must find its entire food needs within the city: Bristol's Swifts feeding over the South Avon reservoirs, or its breeding gulls scavenging outside the town are not "urbanised"; the suburban House Martins - or some of them - may be, if the creation of smokeless zones has restored sufficient air-borne insect life.

Isolation from the countryside implies that the area containing the urban population must be substantially bigger than the home range of its individuals (that is, the typical space in which an individual or a pair leads its life). It follows that one species might be urbanised in a given area while another more mobile species might not. An urbanised population of (sedentary) House Sparrows might be preyed on by wide-ranging Sparrowhawks that sometimes hunt outside the city and so are not urbanised.

THE URBANISED SPECIES

Which of Bristol's species, then, may have urbanised, rather than merely synanthropic, populations? The very features which give the city so rich a bird life - the ample connecting links to the exterior, discussed earlier, and the rich mosaic of habitats with many interfaces between different types - mean that birds of many species can readily come and go (Turcek, 1966) and so may well fail to meet our criterion of isolation inside the city.

The supreme example of an urbanised bird is the House Sparrow, already commented on. So adapted is **Passer domesticus** to an urban existence that on introduction to the USA the birds spread by travelling in railway wagons, and having arrived at a new town occupied the centre in preference to the suburbs (Summers-Smith, 1963). Their optimum habitat contains houses, set fairly close together and either occupied or at least with occupied neighbours, to provide food and preferably with patches of open ground where invertebrate food for their young can be found. A few appear to live entirely under cover, as in main railway stations or other large structures used regularly by numbers of humans. In the last decade House Sparrow numbers have declined in Western Europe, for reasons so far unknown. It appears that urbanised populations populations are involved, as well as those depending partly on rural resources. The cause may be related to problems in finding nest sites, since there has been no apparent decline in urban food supplies over this period.

The Columbidae provide three excellent examples of urbanisation in the Feral Pigeon, Collared Dove and Woodpigeon. The Feral Pigeon, descendant of the wild Rock Dove, has been urbanised for thousands of years (Simms, 1979). With the House Sparrow it supplies by far the largest fraction of the birds breeding in the inner city, and can become so numerous as to be a nuisance requiring regular control measures; Simms (**ibid.** p. 134) cites a report that in 1961 over 50 tons of droppings and nest debris were removed from the roof of the old Foreign Office in London's Whitehall. Substantial flocks may gather to feed, relying largely on the proclivity of humans to feed them. These flocks are not coherent social units and break up to roost; several birds often roost together, preferably under cover or at least with shelter behind them. Nest sites are in crevices and apertures, more readily found in "Victorian Gothic" than on modern buildings, and the availability of suitable roosts and nest sites can influence the distribution of the birds within the city. Gompertz (1957) suggested that the species' success in suburban London was partly due to a shortage of ladders long enough to allow access to the roofs and ventilators of tall Victorian houses with rich ornamentation in a poor state of repair.

The Collared Dove, a highly synanthropic species, spread north-west across Europe from the Middle East, moving from one human settlement to another. It reached Bristol in 1961 when a pair nested at the top of a tall conifer in a Shirehampton garden. Numbers increased rapidly and large flocks formed, in particular at Avonmouth Docks and in the grounds of Clifton Zoo, where spilt grain and other anthropogenic food supplies were readily available. Large flocks may act as a trigger to further advance; at all events, ringing studies showed that the first birds to colonise Ireland came from these Bristol flocks. More recently large flocks have not been reported, but the species is now generally distributed and normally sedentary both in the city and in the countryside, always in association with humans. Nationally numbers may have passed a peak, but locally they seem to be stable.

The Woodpigeon is widespread in both town and country, though in rural areas it tends to avoid human habitations. In London parks it has been recorded behaving in a similar fashion to the Feral Pigeon, though there are no records of this in Bristol. It is distributed more widely within the city than the Feral Pigeon but since it roosts and nests in trees it is absent from the most densely built-up areas, particularly in the breeding season. These are precisely the areas most attractive to the Feral Pigeon and so, in about one-third of the area occupied by the latter, the Woodpigeon is not a rival. There is some evidence (Bland, 1987) that the Woodpigeon is becoming more frequent in the Clifton area than it once was.

Starlings live and breed in the city, nesting in roof-spaces where poor maintenance allows them access. However their breeding cycle is highly attuned to the appearance of cranefly larvae ("leatherjackets"), for which they will fly long distances from the nest, and as soon as their young can fly they are taken out of the city to meadows where these insects are available. Consequently there is a period of two to three months, roughly June to August, when Starling numbers in urban areas is very low indeed. Therefore they do not fulfil our criterion of existence independently of the rural surroundings. Their return in winter is familiar to those who have bird-tables, and they usually form a quarter of the birds using winter gardens. In severe winters they may be joined by very large numbers of continental immigrants, not to be confused with the large numbers of Starlings from the rural surroundings which regularly enter the city on winter evenings to roost.

The crows have historically been a synanthropic group. The dark presence of a rooftop Raven was a classic ill omen, as witness Shakespeare: "The Raven himself is hoarse That croaks the fatal entrance of Duncan under my battlements" (Macbeth, I, v) and "As doth the Raven o'er the infected house, Boding to all" (Othello, IV, i). Nowadays Britain's only urban Ravens are probably those forced to reside at the Tower of London. Magpies, however, are increasingly frequent in many towns. In Bristol their numbers have grown perhaps threefold in the last decade, and they are now absent only from densely built-up areas lacking bushes or trees for nest-sites. Their aggressive presence at winter bird-tables is now commonly noted. In February and March large flocks sometimes form, which may lead to a mixture of urban and rural birds but, as Magpies are generally faithful to their breeding sites, many of the city's pairs must by now be entirely urbanised. Carrion Crows are perhaps the most urbanised corvids; they too occur throughout Bristol, their distribution limited only by the need for trees in which to nest. Large numbers, probably mostly non-breeding birds, often gather at rubbish dumps and on the banks of the Avon but otherwise they are largely solitary. They rarely visit gardens in winter. A survey of the city's 126 one-km squares made in 1979 to 1981 (Bland, 1982b) found 149 Magpies' nests in 107 squares, and 179 Carrion Crows' nests in 102 squares. Jackdaws readily nest on buildings, though in Bristol the presence of many cliffs ensures that the majority actually nest in natural sites in the Avon Gorge, as well as in the woodland areas; it is likely that many feed outside the city, and so in our terms they are not urbanised. They are absent from many densely built-up areas.

Of the common birds of gardens, Blackbird, Song Thrush, Robin, Wren, Dunnock, Blue Tit, Great Tit and Chaffinch, few fulfil our criterion. They are common in suburban gardens because they are nationally the commonest species, on farmland and in woodland. Neither the tits nor the Chaffinch are actually sedentary, but in winter are highly mobile and the winter populations can have substantial additions from Europe. Song thrushes, which have become far less common nationally in recent years, show rather complex patterns of winter movement in Britain, as well as immigration from the Continent, but ringing studies show that fewer birds migrate away from the south than from the north of Britain; also, in hard winters there can be substantial movements towards the south-west (Lack, 1986). Blackbirds also immigrate from the Continent in winter when also many northern British birds move south. The number using gardens may often double abruptly, showing the mobility of the species. However, colour ringing has shown that at least some Song Thrushes and Blackbirds are sedentary, so that the inner suburbs may have small urbanised populations.

Robin, Dunnock and Wren are all very sedentary species, usually defending a winter territory in or near which they later breed. The urban populations of these species are thus distinct from those in the countryside. Robin and Dunnock will use bird-table food, and the Wren is famous for taking over human objects as nest sites; a recently reported example was a pocket in a pair of jeans left overnight on a rotary clothes dryer (Arnold, 1989). In terms of our relaxed definition, allowing migrants to be considered, the only likely cases are small breeding populations of Blackcap, Chiffchaff and Spotted Flycatcher in the suburbs and in the inner green areas, and a small winter population of Blackcaps - immigrants from Northern Europe and not the summer visitors (Langslow, 1979). All the remaining species may well wander to and fro across the boundary.

CONCLUSIONS

The great variety of the environment ensures that the birds of modern Bristol are substantially the same as those of Avon county. The 1967-77 survey recorded 190 species or subspecies within the administrative boundary, of which 58 species were rare in the sense that they were seen fewer than ten times in the course of the survey; 84 species bred, and 72 were resident throughout the year. In contrast, the Avon County Winter Atlas recorded 170 species in the county in 1981-84 (Bland, 1985) and the Avon Breeding Atlas showed 86 species breeding in 1% or more of the area in 1985-87 (Bland, 1987).

We conclude however that fewer than a dozen residents, no more than three summer visitors and one winter visitor can be claimed to have populations that rely entirely on the urban environment. All the others either certainly or with a strong probability rely to some extent on outside resources. Within the densely built-up urban core, only two species - House Sparrow and Feral Pigeon - can be relied on to be present, and they are both urbanised.

Urban areas offer a combination of nest sites, food and protection that enables some species to breed at a density greater than in the countryside (Bland, 1979), and in winter they provide shelter and food resources, natural and anthropogenic, that ensure the survival both of urban populations and of birds that invade the city from the country. The planting of appropriate shrubs can make both gardens and parkland even more valuable (Glue, 1982). Though predation may be at a high level, it is often lower than in woodland or farmland (O'Connor & Shrubb, 1986).

Indeed, the only major disadvantage of urban areas is that there are some species that cannot adapt to them, and whose populations will decrease as urban growth continues. But so long as there are sensitively maintained parks; so long as trees and shrubs are planted, and ponds and lakes dug; so long as waste areas and rubbish tips continue to exist; so long as house owners permit their roof spaces to be used as nest sites and put out food on their bird-tables; just so long will Bristol continue to be as attractive to birds as it is. In many, though not in all ways, the more attractive an area is for humans, the more attractive it is to birds.

ACKNOWLEDGEMENTS

We are grateful to A.E. Frey for advice, particularly on the historical growth of Bristol, and to a referee for helpful comments.

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PLATES

The aerial views in the following three plates, taken at various times, show a range of urban habitats: the River Avon in the heart of the city, docks and industrial sites (some derelict), the Bristol - Exeter railway line, the important wildlife area of Brandon Hill adjacent to Clifton with its many gardens and trees, the dense late-Victorian housing in Bedminster south of the river and the numerous 'islands' of trees connecting the heart of the city with intruding open country. We are indebted to Avon County Council and the Bristol University Department of Geography for the use of these plates.

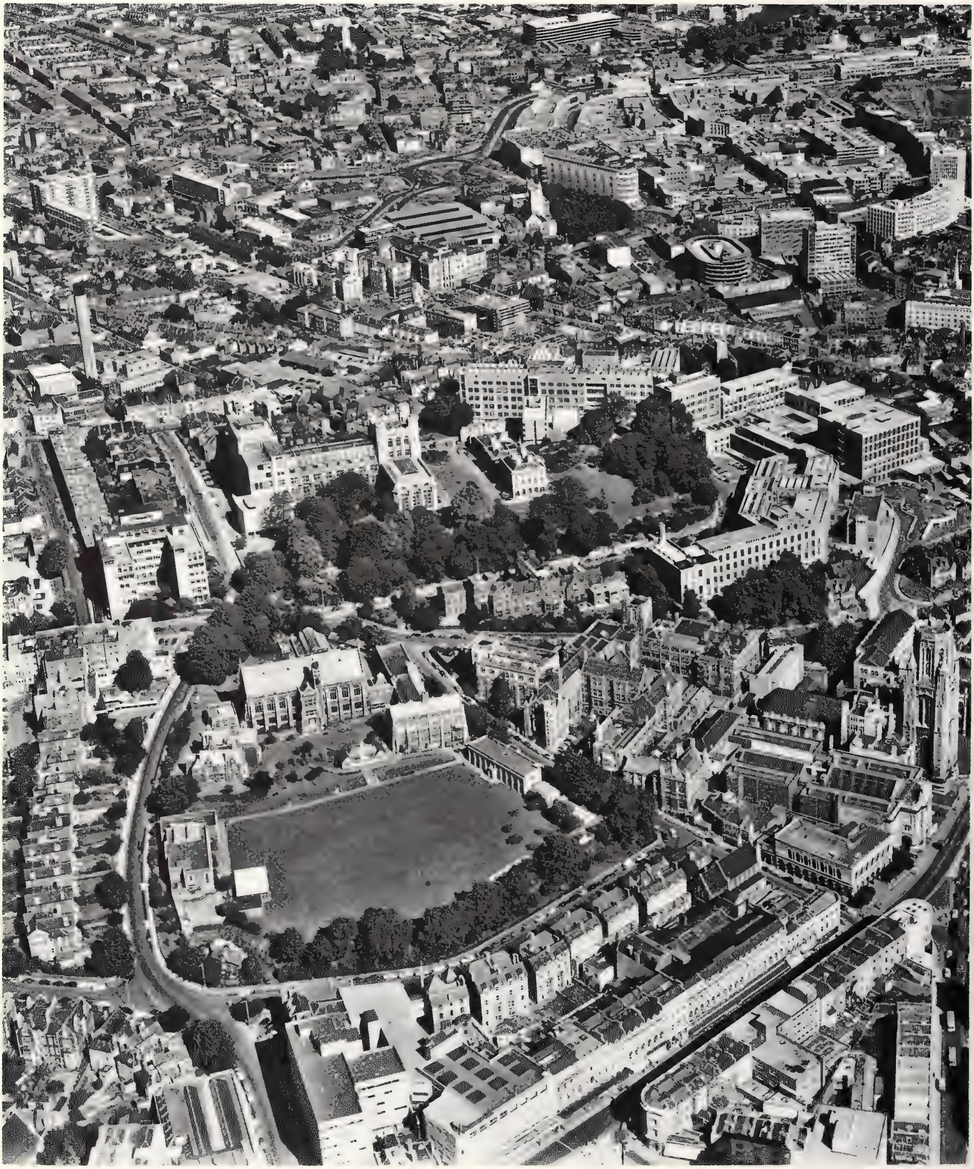

PLATE 1 **The University area and Bristol Grammar School.** Note the extensive trees in the Royal Fort area and the many trees and shrubs in gardens. Queen's Road is in the foreground with the City Museum and Art Gallery and the University Tower on the extreme right. Since the photograph was taken, Bristol Grammar School field in the foreground has been partly built on.

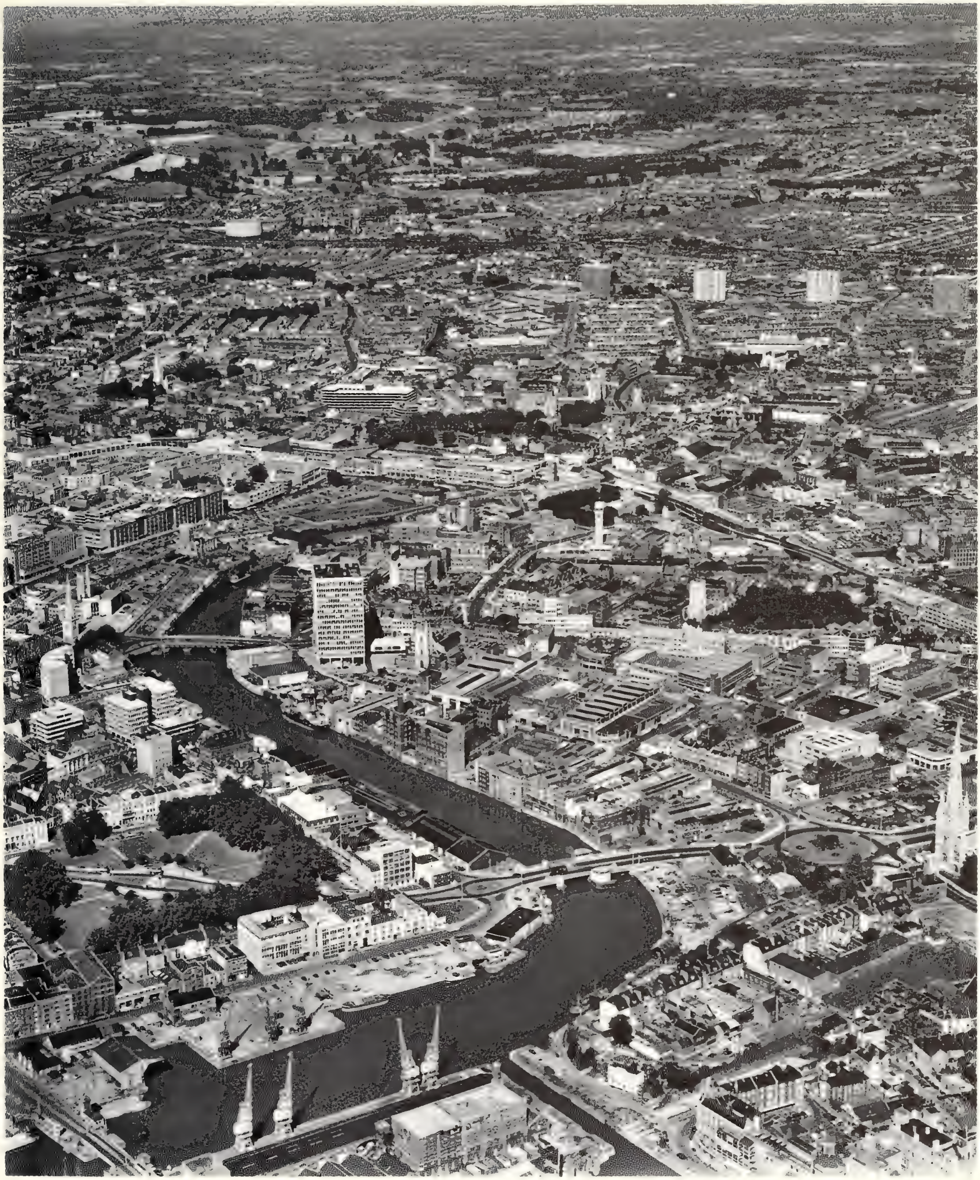

PLATE 2 Looking north-east from Redcliffe Wharf. In the far distance the open areas of Purdown, Eastville Park and the Oldbury Court estate lie between the built-up areas of Lockleaze on the left and Stapleton and Fishponds on the right. The M32 motorway, then under construction, is just visible. Note the many tree clumps linking Queen Square and St. Mary Redcliffe Church in the foreground with the open country.

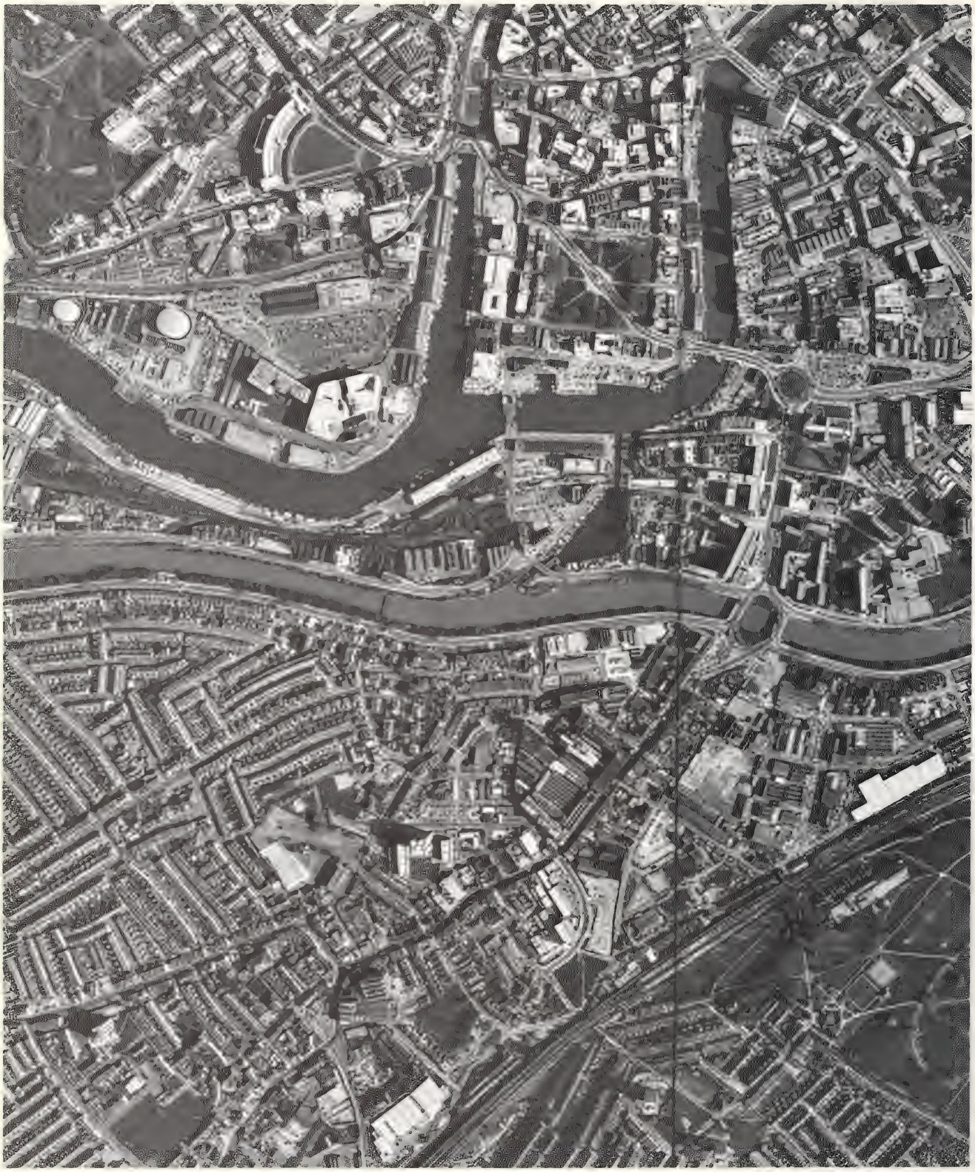

PLATE 3 **Bedminster and the Floating Harbour.** The dense housing of Southville and Bedminster in the foreground provide little natural cover. Victoria Park, just visible on the right, has little shrub cover; the railway line forms a corridor for wildlife. Note the contrast with the older green areas of Brandon Hill and Queen Square north of the river. The old gasworks at Canon's Marsh is visible on the left.

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BUILDING STONES OF CLIFTON

by R.J.G. SAVAGE

(Department of Geology, The University, Bristol BS8 1RJ)

> "Whoever could master the geology of the neighbourhood of Bristol was fit to study geology in any part of the world."
>
> H. de la Beche

ABSTRACT

The major types of building stones used in Clifton are described in stratigraphic order, and each type of stone is related to its availability and to the historical time period in which it was used for building in Clifton.

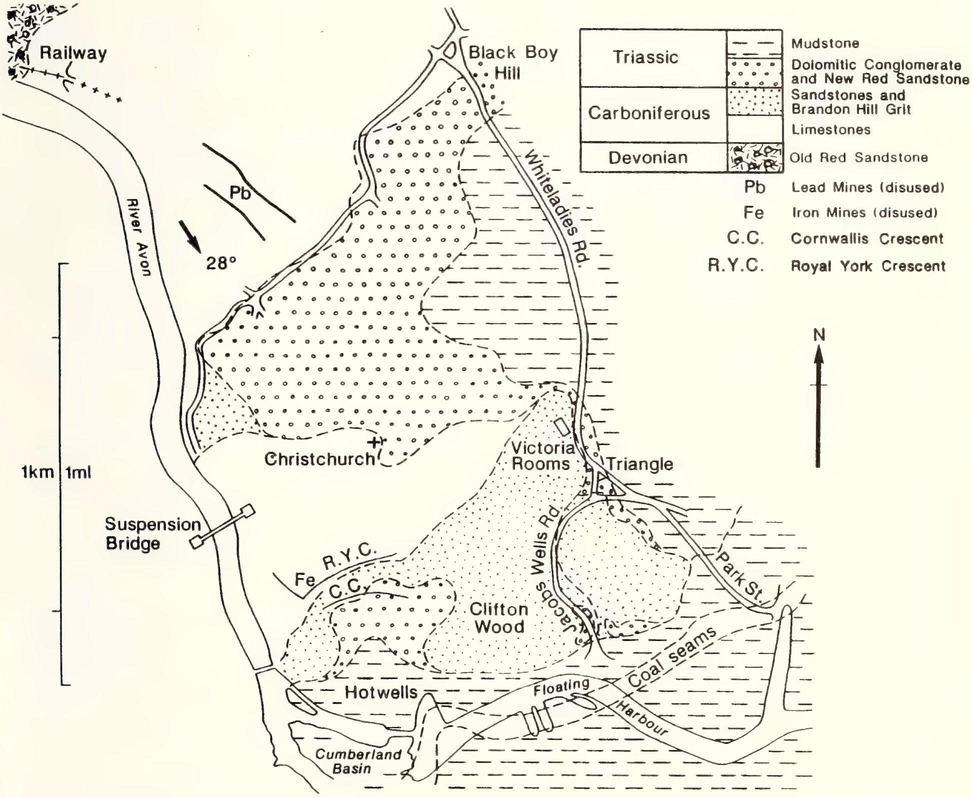
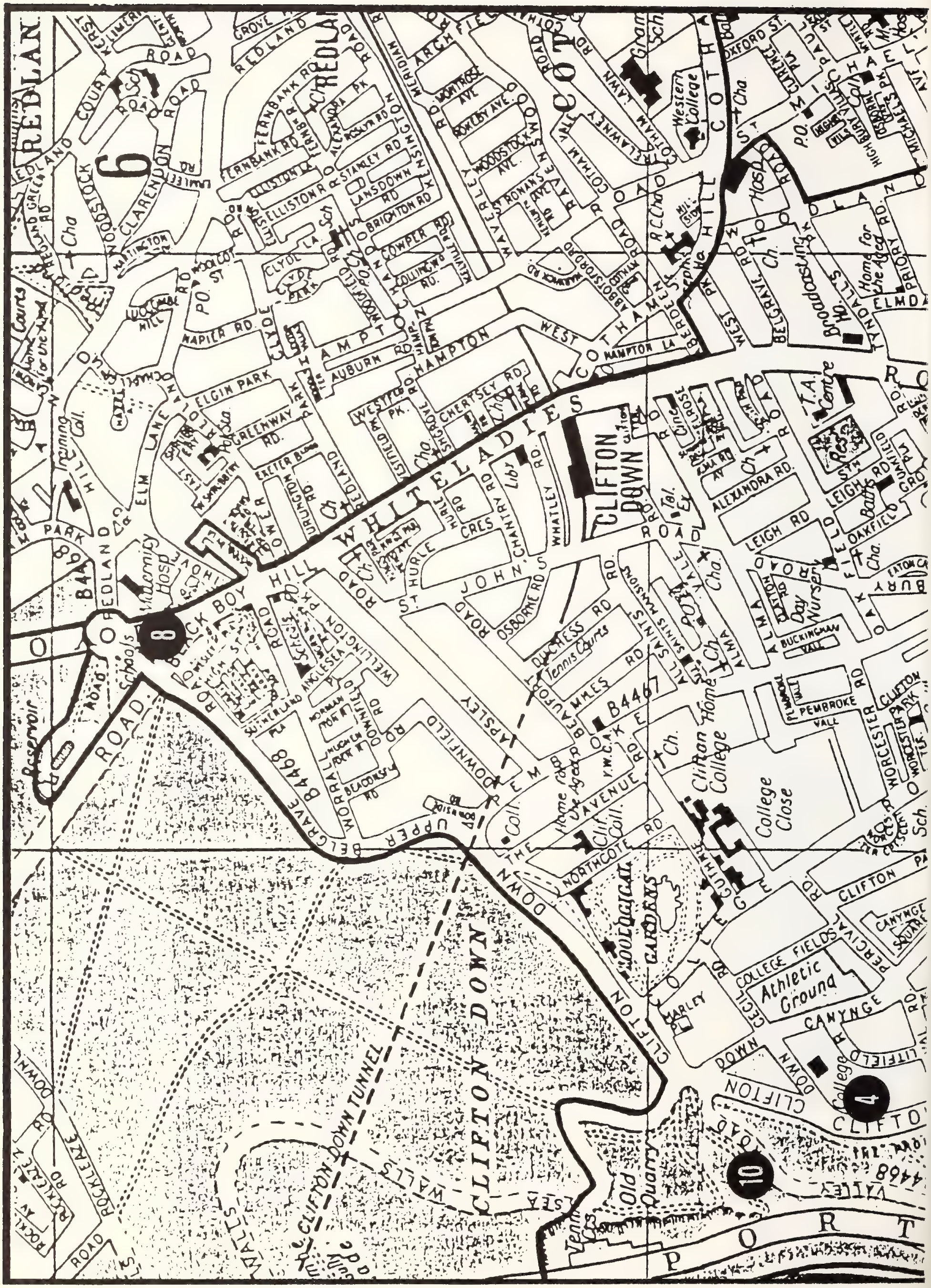

Railway
Black Boy Hill
River Avon
Pb
28°
Whiteladies Rd.
Triassic
Mudstone
Dolomitic Conglomerate and New Red Sandstone
Carboniferous
Sandstones and Brandon Hill Grit
Limestones
Devonian
Old Red Sandstone
Pb Lead Mines (disused)
Fe Iron Mines (disused)
C.C. Cornwallis Crescent
R.Y.C. Royal York Crescent
N
1km
1ml
Christchurch
Victoria Rooms
Triangle
Suspension Bridge
R.Y.C.
Fe
C.C.
Clifton Wood
Wells Rd.
Jacobs
Park St.
Coal seams
Hotwells
Floating Harbour
Cumberland Basin

FIGURE 1 A geological sketch map of Clifton, Bristol.


REDLAND
COTHAM
WHITELADIES
ROAD
CLIFTON DOWN
CLIFTON DOWN TUNNEL
BLACK BOY HILL
HAMPTON RD
ELGIN PARK
ELM LANE
REDLAND RD
WOODSTOCK
CLARENDON RD
CHERTSEY RD
ST. JOHN'S RD
APSLEY RD
DOWNFIELD RD
BELGRAVE RD
UPPER BELGRAVE RD
DUCHESS RD
Tennis Courts
BEAUFORT RD
PEMBROKE RD
OAKFIELD RD
ALEXANDRA RD
LEIGH RD
ALMA RD
COLLEGE RD
Clifton College
College Close
Athletic Ground
Zoological Gardens
NORTHCOTE RD
CANYNGE RD
ALL SAINTS RD
Old Quarry
Reservoir
Maternity Hosp
Broadcasting Ho.
Home for the Aged
Western College
Training Coll.
COTHAM HILL
CLIFTON DOWN RD
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PORT
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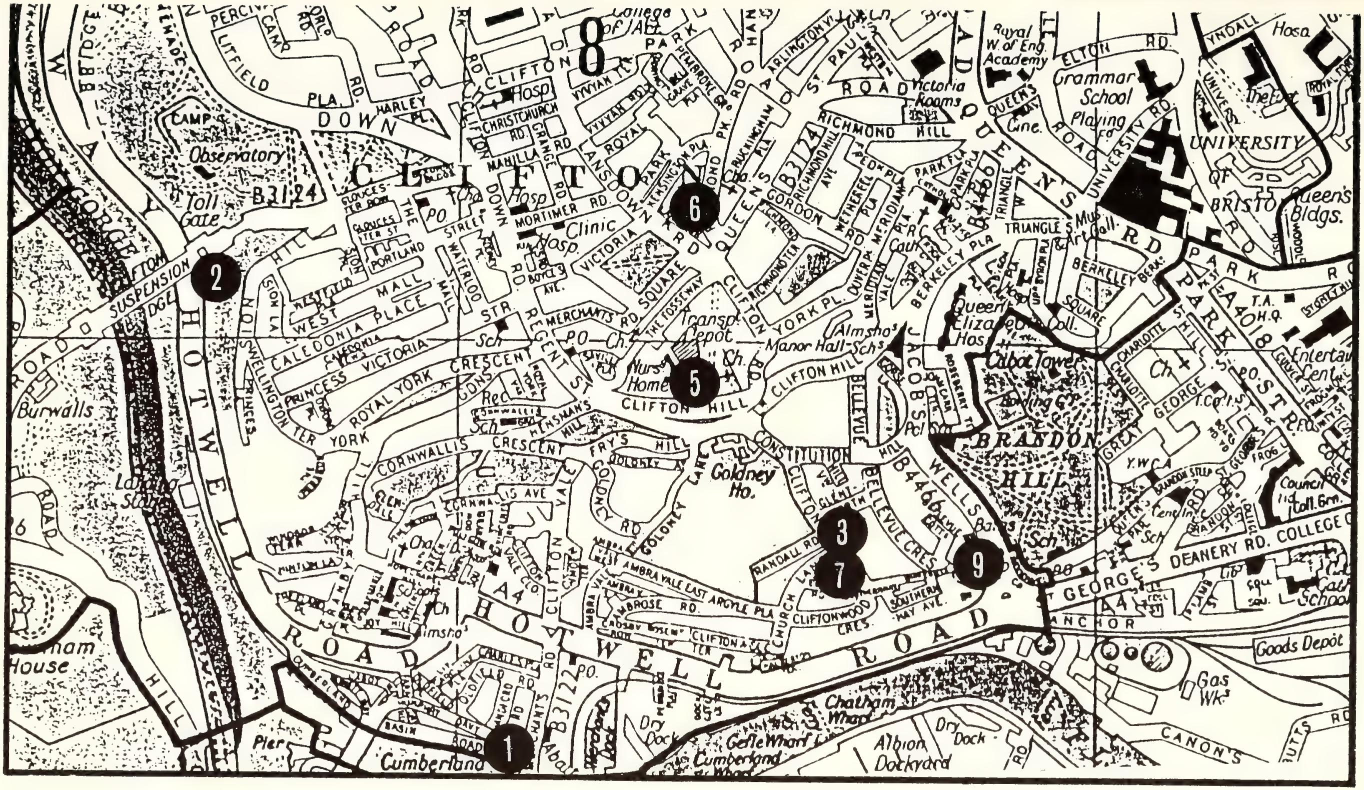
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CLIFTON
HOTWELL ROAD
HOTWELL
SUSPENSION
Observatory
Toll Gate
B3124
QUEENS RD
UNIVERSITY OF BRISTOL
PARK ST
A4018
BRANDON HILL
Cabot Tower
JACOBS WELLS
B4466
CLIFTON HILL
Goldney Ho.
ROYAL YORK CRESCENT
CORNWALLIS CRESCENT
REGENT ST
VICTORIA SQUARE
ST GEORGE'S RD
A4
ANCHOR
Goods Depot
Gas Wks
Chatham Wharf
Albion Dockyard
Dry Dock
Cumberland
Burwalls
Pier
Grammar School
Victoria Rooms
Royal W. of Eng. Academy

FIGURE 2 Some Clifton buildings using distinctive materials. The numbers on the map indicate the locations of the photographs.

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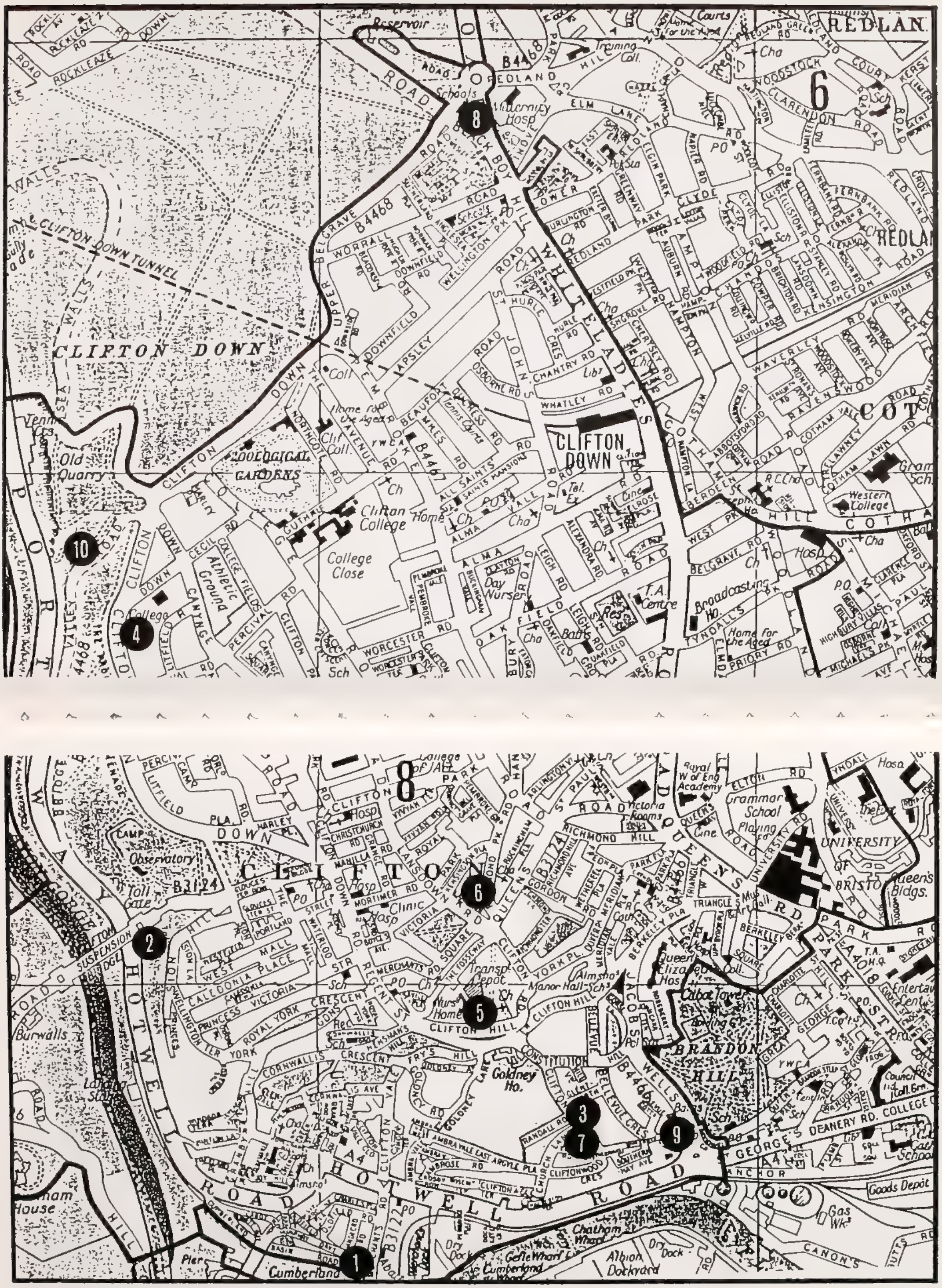
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CLIFTON DOWN
CLIFTON
REDLAND
COTHAM
ZOOLOGICAL GARDENS
Clifton College
College Close
WHITELADIES ROAD
Old Quarry
Observatory
SUSPENSION BRIDGE
HOTWELL ROAD
BRANDON HILL
Cabot Tower
UNIVERSITY OF BRISTOL
Goldney Ho.
Victoria Rooms
Cumberland Basin
Albion Dockyard
Goods Depot

FIGURE 2 Some Clifton buildings using distinctive materials. The numbers on the map indicate the locations of the photographs.

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INTRODUCTION

The Bristol suburb of Clifton has a long history; its buildings are architecturally among the most interesting in the city, and the materials used in their construction vary with the age of the building, the area within Clifton and type of use.

The limits of the area described in this paper are essentially those of the old Clifton Parish and therefore include Clifton Wood and Hotwells. They may be defined approximately by the Portway, Clifton Down, Whiteladies Road, Jacob's Wells Road and Hotwells Road. Within this small area of about four square kilometres there are the magnificent scenic attractions of the Avon Gorge and Clifton Down. The geology is varied and has commanded attention since the 16th century, the first important geological contribution being that of Owen (1754), in which he gives a remarkably clear and detailed account of the Avon Gorge, the Hotwells, Bristol Diamonds and Landscape Marble.

The simplified geological map of Clifton (Figure 1) shows the major rock types. The oldest rocks are the Old Red Sandstones of Devonian age on the northwest edge, seen near the point where the Avonmouth - Clifton railway enters the tunnel at the north end of the gorge. The Downs are the peneplained top of the southerly dipping Lower Carboniferous rocks, mostly limestones as far south as Bridge Valley Road, where they give way to sandstones. A reverse fault causes a repetition of the succession to the south of the Suspension Bridge and the sandstones reappear in Hotwells, continuing on to coarse grits on Brandon Hill. The Upper Carboniferous Coal Measures occur only in the basin to the south in Ashton Vale. The Permian was a time of uplift and erosion, so the succeeding Triassic rocks in Clifton rest unconformably on the Carboniferous. There are boulder conglomerates (as in Bridge Valley Road) and angular breccias (the so-called Dolomitic Conglomerate) which cover most of eastern Clifton. The conglomeratic Triassic facies pass laterally into sandstones (red or cream) which are well seen in the railway cutting near Clifton Down Station. The Triassic is capped by Rhaetic limestones which are known locally as the Cotham Beds and include the famous Landscape Marble. Unfortunately these interesting rock types of Cotham appear to stop short about Whiteladies Road and so do not quite occur within Clifton. Likewise the Lower Jurassic Lias limestones and calcareous mudstones outcrop only east of Clifton.

In the past the Clifton area was economically important with lead mines on the Downs (Gough, 1930), an iron mine below Royal York Crescent, lime kilns in the Gorge and coal mines just beyond the boundaries in Ashton Vale., The local stones used for buildings included the limestones of the Gorge, the Brandon Hill grits and sandstones and the softer Triassic conglomerates and sandstones. The only published account of the building stones of Bristol is just a century old (Lloyd Morgan, 1888) and that paper gives a generalised account of some of the major building stones used in the city of Bristol, with emphasis on their mechanical properties; Lloyd Morgan quoted densities and analysed both their porosity and crushing strength.

The Manor of Clifton is recorded in Domesday but it passed through many ownerships until, in the 17th century, it was purchased by the Society of Merchant Venturers. It was probably about this time that merchants' houses began to rise around the Manor, the Green and Parish Church of St. Andrew's [the area occupied today by the Chesterfield Nursing Home, the Bishop's House, Manor Hall and Goldney House]. In the Civil War, Clifton was in a key position for the defence of Bristol, commanding open views of the city. In 1645 Prince Rupert ordered the firing of Clifton that it might not be used for water, supplies or shelter for the Parliamentarian troops; accordingly it is unlikely that any substantial structures in Clifton predate the 1660s. From the late 17th century probably date some of the outbuildings of Goldney House, World's End House in Clifton Wood and some of the cottages near Christ Church Green. Developments through the 18th and 19th centuries can be traced using a series of Clifton street maps. The introduction of such materials as Bath stone and Pennant sandstone can be dated from the architectural histories, especially useful being Gomme **et al.** (1979) and Ison (1952).

BUILDING STONES

In this account the building materials will be treated in type order (igneous, sedimentary, metamorphic and manufactured), regardless of whether they are local, native or foreign rock types. No attempt is made to describe shop fronts, where nowadays many exotic materials, both natural and artificial, are used; perhaps happily these fronts appear to be very ephemeral. The account is not exhaustive and there are many very minor occurrences which are omitted like for example, the use of Carrara and other marbles as doorsteps on houses, granite fountains and the use of small decorative pillars of granite on churches. No interiors of churches are described, nor are the gravestones in the cemeteries. Wherever possible, the examples chosen are taken from those buildings which best display the features of each stone and from buildings which can be reliably dated.

1. IGNEOUS

No igneous rocks occur in Bristol and all examples are imported, mostly from Cornwall. The most extensively used of these are the Cornish granites, seen in the Cumberland Basin and along the docksides of the Floating Harbour.

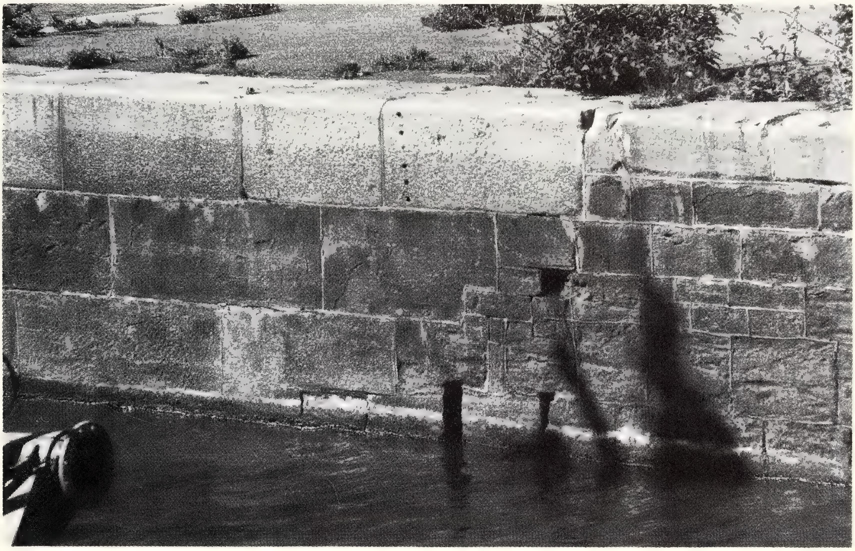

PLATE 1 Walling in Cumberland Basin. Capping of Dartmoor Granite on left and of Carboniferous Limestone on the extreme right; facings below are in Pennant.

Analysis of granite in the Cumberland Basin shows it to be closest to the Bodmin granites. Lloyd Morgan (1888) wrote "Lundy granite was, I am told, used for the harbour works at Cumberland Basin" (p. 96). I can find no trace of Lundy Island granite in the dock area; it is quite distinct from the Cornish granites and I can only conclude that either it has been replaced when the lockgates to the Cumberland Basin were rebuilt in 1844 to allow Brunel's ship **Great Britain** to pass out of the harbour, or that Lloyd Morgan was misinformed. The Lundy Granite quarries were worked for only a brief period of seven years before going into liquidation in 1870; they are on the east side of the island, so that east winds and the lack of a harbour made shipment hazardous.

The kerbstones in Clifton are often granite or syenite, as are the square blocks seen along the drainage margins of the road. These are relicts of earlier times before the use of macadam, when square or rectangular blocks would have been used to form the whole road surface. The most consistent use of igneous kerbstones is to be seen lining the roads around Clifton Down.

2. SEDIMENTARY

DEVONIAN - OLD RED SANDSTONE

Though not quite a local Clifton rock, Old Red Sandstone occurs on the margins of Clifton and is used in neighbouring Shirehampton and Stoke Bishop. It is little seen in Clifton but its clearest expression is to be seen in the facings of the walling around the pier to the Suspension Bridge (1843), immediately below road level on the Clifton side. Lloyd Morgan (1888, p. 100) reported that the stone came from a quarry on the Somerset side of the Avon and, while this

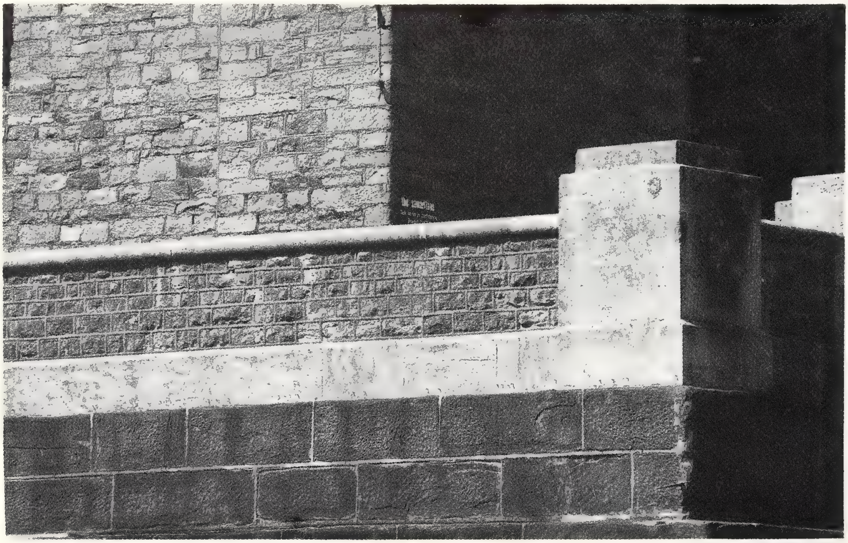

PLATE 2 Clifton pier of Suspension Bridge built of grey Pennant Sandstone. The walling below is faced in Old Red Sandstone with five courses of Triassic Sandstone above. The corner pillar, top rail and course between the two red sandstones are in Bathstone.

is not impossible, it could equally likely have come from the Portbury - Portishead area where the occurences are more extensive. It has a deep red colour, is well cemented and even grained with few bedding features so that it makes an attractive and hard weathering building stone.

CARBONIFEROUS LIMESTONE

The several varieties of limestone in the local Lower Carboniferous succession - crinoidal, algal, shelly, oolitic and so on - are all hard, dense, compact stones with low porosities and good crushing strength. They have been much exploited from quarries in the Avon Gorge and on the Downs. The earliest reference on quarrying goes back to 1626 when a Clifton limeburner was given a lease for a kiln and quarry in Leigh Woods. During the nineteenth century, quarries on the Downs were infilled with material taken from excavations at the entrance to the Floating Harbour (Wells, 1909). In 1935 Mr Melville Wills purchased the last working quarry in the Gorge below Leigh Woods (Lovatt, 1989). Remains of two quarries are still to be seen; one in the angle between Redland Hill and Durdham Park and the other near Quarry Steps, just east of Black Boy Hill. The latter of these quarries is famous as the site of a dinosaur, found in a Triassic fissure in the limestone.

The main use for the stone before the 19th century was for lime. Lime kilns are a distinctive feature of 18th century paintings of the Avon Gorge. Owen (1754) mentioned that much stone was extracted from quarries on Durdham Downs and the frontispiece of his book depicts a lime kiln in the Gorge below St. Vincent's Rock. Nearly 40 years later Ibbetson **et al.** (1793) recorded that there were many quarries in the Gorge. Matthews (1794) reports that St. Vincent's Rocks are used frequently in chimney-pieces [fireplace surrounds] but their principal use is for making lime. The chimney-piece in the Mahogany Parlour at Goldney House is made of this white veined limestone (Savage, 1989).

The nearest mid-18th century houses to the Gorge are in Dowry Square; most have stucco-rendered walls but, when and where visible, the core is seen to be of Brandon Hill Grit. Chilcott (1844) writing of St. Vincent's Rocks declares that 'the venerable appearance of these rocks is greatly lessened within the last fifty years, by the operation of blasting and taking away the fine old grey surfaces, "rich with fantastic foliage;" selling, as Southey observes, "the sublime and beautiful by the boat load." But the stone, it is said, makes the best lime in the world; and this is the sweeping answer to all our regrets.' (p. 281-282).

The Carboniferous Limestone appears to have been little used as building stone other than for rubble walling. The earliest use for building is probably in the Observatory on Clifton Down. This was built as a windmill for snuff making about 1729. It was destroyed by fire in 1777 and the surviving tower converted to a camera obscura in 1829. Carboniferous Limestone is used in the garden walling of Clifton Vale (1841). Avonbank and Llanfoist, a pair of Italianate villas just beyond the Mansion House on Clifton Down (1850s) are faced with Carboniferous Limestone; the garden walling of the villas in this row is built of the same greyish limestone. Among the varieties of Carboniferous Limestone used, one that is common and easily recognised is the Gully Oolite; a greyish oolitic limestone which weathers to give an intensely white surface; examples of its use in walling are to be seen at Montrose House and Tortworth House (90 & 92 Queens Road), and again in the walling at the junction of Harley Place and Canynge Road. Garden and boundary walling in Hotwells and Clifton is for the most part made of any materials that came to hand and Carboniferous Limestone is thus frequently found along with Pennant, Triassic sandstone and Brandon Hill Grit. Such walling can rarely be dated as it was frequently repaired or replaced with different materials.

BRANDON HILL GRIT

Brandon Hill is a prominent Bristol landmark; according to Matthews (1794) it is one of the seven hills upon which Bristol, like Rome, is built. In the 17th century it was described as "a publik convenienc to ye cittie for ye use of drying cloaths" (Millerd, 1673). Among the remains of fortifications on the hill can be seen remains of old quarries which for centuries were a source of excellent building material and the stone work is still to be seen in much of Hotwells, Clifton Wood and around Brandon Hill itself, but is little used in buildings more than a mile beyond the quarries. For the most part the stone is a medium grained sandstone with a particularly strong siliceous cement. Periodic channels in the sands are infilled with coarse grits, carrying well rounded quartzite pebbles. The overall colour is red, varying from pink to deep blackish red, the colouring being due to staining with iron and manganese minerals, probably

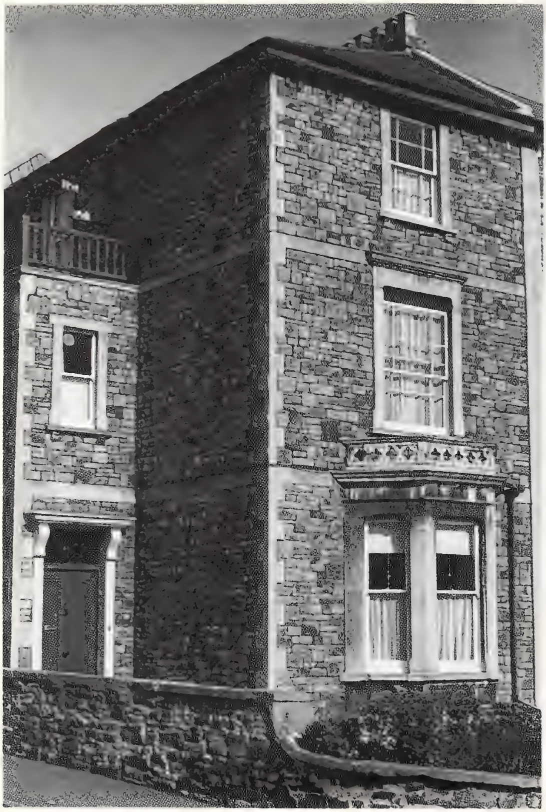

PLATE 3 House in Cliftonwood faced in coursed Brandon Hill Grit with Bathstone quoins, string courses and window architraves.

during Triassic times. These siliceous sandstones are very resistant to weathering and therefore excellent building stones. They are however very difficult to work, and the dressing of stones into square blocks for coursed work must have been very wasteful and expensive. For the most part the stone is used in uncoursed rubble walling and as infill backing behind facings of Bath stone or stucco rendered walls. The coach house and other outbuildings of Goldney House are all in Brandon Hill Grit, which also outcrops on the site; some parts of these buildings are certainly older than the present house (1720s and 1860s) and could go back to the 17th century. However, there are examples of its use in trimmed blocks in houses of Glenworth Road and Bellevue Crescent, Clifton Wood (1864). Another excellent example, just beyond our boundaries, is the Bluecoat School (Queen Elizabeth's Hospital) on Brandon Hill (1843).

PENNANT SANDSTONE

Pennant is by far the most ubiquitous building stone in Bristol, yet it does not dominate over others in Clifton. The sandstone is predominantly grey in colour, though often stained red or purplish red with iron and manganese minerals. Black streaks of fossil plants are frequently seen and it is usually micaceous, these sandstones being essentially the unproductive beds between the Lower and Upper Coal Measures. The sand grains are poorly cemented and thus the stone, while it is easily quarried and cut for rubble coursing, does not weather well. In the acid-laden Bristol air, it has a very poor record. Some of the beds fom good flagstones and these fare well as paving stones.

There is no outcrop of Pennant within Clifton, though it occurs in Ashton Vale, and the main sources of this building stone are quarries in east Bristol, at Hanham, Fishponds and Stapleton. Anstie (1873) wrote "Between Brislington and Troopers' Hill the whole thickness of the Pennant series may be seen and measured ...... about 600 yards. It is a compact and evenly bedded stone and much quarried at Hanham for building use in Bristol" (p. 66). Hanham is still dotted with old quarries from which the stone was brought by barge along the River Avon to Clifton. Despite the proximity of the stone, the ease of quarrying (compared with Brandon Hill Grit) and its abundant use in central Bristol, there is little evidence that it was used more than occasionally in Clifton until well into the 19th century; then in late Victorian times it became very popular. Lloyd Morgan (1888) wrote "Pennant Sandstone would seem to be the favourite building stone of modern Clifton ...... The great disadvantage of the stone is the disability to stand mason's tools, the face in time peeling off ...... Within the last few years some of the quarry masters have sawn the solid block in the quarry into paving and steps which will not peel or perish on the surface ...... For house building it is now generally regarded as the best stone" (p. 99). It was much used in the building boom of the 1880s and early 1890s.

Most Clifton pavements which have not been replaced by concrete slabs, macadam or other aggregate material, are laid with Pennant flagstones. The surfaces are often tooled, that is deep parallel scratches are cut across the stones. These have two functions; they help disperse the rainwater rapidly and so retard the rate of decay of the stone and also they help reduce the risk of pedestrians slipping on flat wet surfaces. These features are well displayed in the paving stones around Christ Church, Clifton. Many kerbstones and steps to houses are in Pennant flagstone, while a particularly attractive use of the flagstones is as mounting blocks, still preserved along Caledonia Place (1843).

Pennant is also widely used in houses erected in the second half of the 19th century. The vast majority of houses between Pembroke Road and Whiteladies Road are built of either Pennant sandstone or Triassic sandstone, or both;

it is quite frequent to dress one wall in Pennant and another in Triassic, as has been done at Channings Hotel in Pembroke Road. The piers to the Clifton Suspension Bridge (erected 1843) are built in Pennant and this was a very early major use for the stone in Clifton. Pennant is sometimes known as the railway stone because the Great Western Railway built by Brunel cuts and tunnels through a two mile stretch of Pennant at St. Anne's and Brislington in eastern Bristol. The Bristol to Bath section was opened in 1840 and the Bath to London section in 1841. Brunel chose Pennant for the railway workshops at Swindon, though not for his terminal station at Temple Meads, preferring there Bath and Blue Lias limestones. One of the few surviving Clifton churches built in Pennant is St. Paul's (1853, rebuilt after fire 1867) in St. Paul's Road. Its fronts facing St. Paul's Road and Arlingham Villas have been repointed, but the front facing Oakfield Place shows the typical crumbling decay of Pennant. All the houses in York Gardens (1890s) are faced with Pennant. The tower on the ventilation shaft for the railway tunnel at the top of Pembroke Road (1877) is in Pennant, as is the Pump House Inn on Cumberland Basin Wharf. Pennant is the most commonly used material in the rubble walling throughout the Clifton area.

DOLOMITIC CONGLOMERATE AND TRIASSIC SANDSTONE

These two rock types are inseparable and often grade into one another. The so-called Dolomitic Conglomerate is a piedmont breccia which formed during Triassic times around the margins of upstanding ridges of Carboniferous Limestone. The matrix is usually sandy and the breccia made up of fragments of Carboniferous Limestone, the whole bound by a calcareous cement. In some instances the limestone fragments may be dolomitised and/or rounded. An excellent example of the large rounded-boulder conglomerate variety is to be seen in Bridge Valley Road and represents a wadi infill, but is quite unsuitable as a building stone. The best example in Bristol of the use of the breccia variety is at Temple Meads Station (the currently used building of 1878 and not the original Brunel station of 1840); this attractive pink stone with pieces of grey Carboniferous limestone came from Draycott Quarry, near Cheddar.

As used in Clifton, Dolomitic Conglomerate contains only small limestone fragments, and in buildings it is used along with Triassic sandstones which contain no breccia fragments. The sandstones vary in colour from pinkish red to orange brown to yellow. This New Red Sandstone is not as well cemented as the Old Red Sandstone, but does make a good durable building stone. The sources of the stone are several, but some could have come locally for it outcrops over much of eastern Clifton. When the Clifton extension line of the GWR was built in the 1870s, a cutting and tunnel were made through Clifton Down and the large quantity of stone made available could well have been used in local housing which was springing up at the time. Clevedon is probably the major source of the stone used in Clifton and several large overgrown quarries can still be seen there; as with the Pennant, the stone could easily have been transported by boat up the River Avon.

Examples of the use of Dolomitic Conglomerate and Triassic sandstone are abundant in the 1860s to 1890s housing development in northeast Clifton between Pembroke Road and Whiteladies Road. Some outstanding examples of its use are to be seen in the recently restored St. John's Church at the corner of Whiteladies Road and Apsley Road (1841), in Clifton College (1862-89) and in All Saints', Pembroke Road (1864). Along Clifton Down several of the large mansions of the 1860s are in Triassic sandstone and these include both the Mansion House and the Merchants House (the latter with a Bath stone ground floor).

PLATE 4 The Merchants House, The Promenade, in red Triassic sandstone with Bathstone facing on the ground floor, quoins and architraves. The garden walling is in Carboniferous Limestone.

LIASSIC LIMESTONE

There are two types of Liassic limestone. Neither outcrops in Clifton, but these rocks underlie much of neighbouring Cotham. The White Lias makes an acceptable building stone although its only use in Clifton is to be found among other rock types in the walling around of the north end of the garden belonging to the houses in the Paragon. The younger Blue Lias succession yields muds and calcareous mudstones; the latter having been worked as grey 'limestone' and is usually to be found in brick-sized blocks in rubble-coursed walling. Blue Lias has a dismal history in Bristol; Lloyd Morgan (1888) wrote "The building stones from the Lias are poor in quality, and are seldom used for aught but common walling ...... wherever Lias has been used, there you will find abundant signs of rapid decay" (p. 102). The only example of Blue Lias used in Clifton is on the ill-fated Catholic pro-Cathedral (1876), where the remains of the crumbling Lias columns can still be seen on the side facing Park Place where the Lias pillars are set in Ham Hill stone, a vivid orangish-brown limestone of Liassic age from quarries near Yeovil in Somerset. The latter stone is a very famous building stone, in use since Saxon times. Montacute House (1590s) is built of it and well preserved, but this coarse grained shelly limonitic limestone does not stand up well to city pollution. In the Pro-Cathedral the Ham Hill stone has weathered almost as badly as the Blue Lias. Other examples of the use of Ham Hill stone are to be seen in the frontage to the Watershed warehouses and in the pillars at the entrance to the Colston Hall.

BATH STONE

The cream-coloured oolitic Jurassic limestone of the Bath area makes an excellent building stone and has been much used there since Roman times. However, its use in Bristol was much more limited and it did not become really fashionable here until late Georgian times. In the 1720s Ralph Allen, an entrepreneur who had made a fortune operating the postal services, bought land on Combe Down, on the south side of Bath, for quarrying Bath stone. About the same time (December 1727) the River Avon was made navigable between Bristol and Bath. Allen in 1731 built a 'railway' system from the Combe Down quarries, to carry the Bath stone 500 feet downhill to the river. These improvements meant that the price of Bath stone plummeted and its use rocketed. Allen was thus able to exploit an expanding building market in Bath and Bristol.

There is an outcrop of a very similar rock on Dundry Hill just south of Bristol, but I know of no instances of its use in Clifton. The quarries at Dundry, which date back to Norman times, were owned by the diocese of Bristol and their use is confined to churches in the city (the Cathedral and St. Mary Redcliffe). Dundry stone may have been used for the parish church of Clifton; this suffered in the civil wars, was rebuilt in the 18th century, pulled down and replaced in the 19th century and destroyed by bombing in the 1940s; the last remnant (the tower) being demolished in the 1950s. However, the quarries have long been abandoned and do not appear to have been much used after the extraction of stone for the 1840s restoration of St. Mary Redcliffe.

The use of Bath stone in Clifton dates from the early 18th century. In the first decades its use was confined to quoins, moulded string courses, and in architraves for doorways and windows with the expanses of wall in between being finished in brick or rendering over rubble stonework. The history of Bath stone will be traced in three parts; its use in churches, in mansions and in terraces.

The first church in Clifton to be built after the Parish Church of St. Andrew was Holy Trinity (1830) in Hotwells Road and it is completely faced in Bath stone. The later 19th century churches and chapels in Clifton were built of a great variety of materials with examples of Bath stone work well seen in Christ Church, Clifton (1841-85) and Buckingham Baptist Chapel, Queen's Road (1842).

Turning to mansions, the earliest of these sprang up around the Parish Church. In the 17th century there were at least two, the Manor and one belonging in the 1690s to Lord Folliott which stood on the opposite side of the Green. The former is now known as the Bishop's House and the latter as Goldney House and their history is outlined below. Other mansions to be erected nearby during the century included Clifton Wood House (1720s), Clifton Grove (1730), Clifton Hill House (1746-50), Clifton Court (1740s), Mortimer House (1760-65), Rodney Lodge (1770s, much altered in 1880s), Cornwallis Grove and Cornwallis House (1770s). All have Bath stone architraves; Clifton Grove is brick faced, Clifton Wood House is rendered, while Cornwallis Grove has a Bath stone central block with rendered wings; the others today all have Bath stone facings, but many have undergone alterations and it is not possible to be certain which, if any of them, began life with Bath stone facings.

The earliest-dated house in Clifton with a Bath stone facing is the Bishop's House where the central block house is faced with Bath stone and carries the date 1711. Little (1962) wrote "The interior has not kept many features that one can safely attribute to 1711". The asymmetrical wings are not faced in Bath stone and the windows have lost their glazing bars. While the projecting central bay with its V-cut horizontal joints may be original, it seems to me that among the many alterations made during the eighteenth century could have been the addition of Bath stone facing to the two bays on either side of the central bay, possibly before the wings were added. Architectural historians are strangely

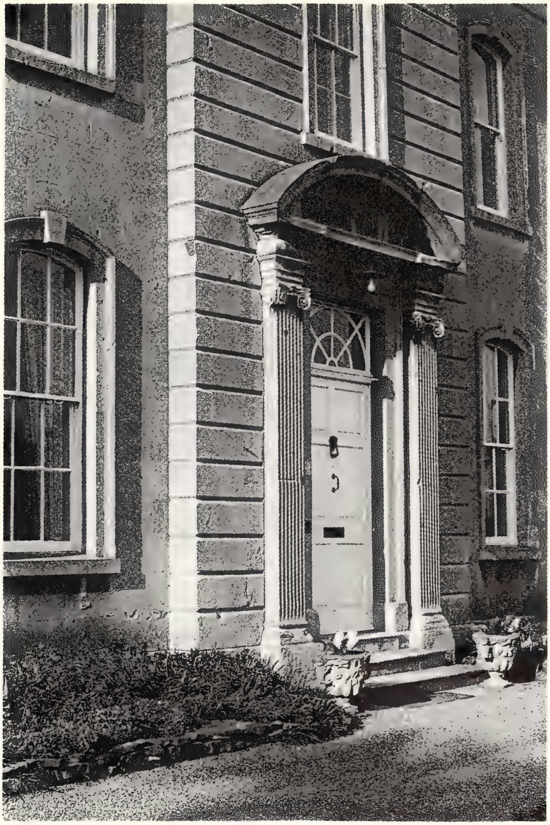

PLATE 5 The Bishop's House (dated on door pediment 1711) faced throughout in Bathstone.

silent on the building history of this important house.

Mr. Goldney's House on the opposite side of Clifton Green was rebuilt in the 1720s and possibly dressed in Bath stone. However, the building was violently mutilated by Waterhouse in 1865. The south (garden) front seems the least altered, though even here the windows have lost their glazing bars and the central doorway architrave has been renewed, but it could be that this Bath stone facing is original. Work on remodelling the house is believed to have been begun in 1723 (Stembridge, 1969) and probably completed before the death of Thomas Goldney in 1731.

If these two mansions, the Bishop's House and Goldney House, were Bath stone faced in 1711 and 1720s, they pre-date the availability of cheap Bath stone, which was after 1731, and thus represent very expensive undertakings.

The next important mansions are Clifton Court and Clifton Hill House, both built in the 1740s. By this time Bath stone was cheap and fashionable in Bristol and other stone-faced mansions followed, though after a gap in time during which the terraces were being built. To the early 19th century belong Norland House in Canynge Road (1820), and in the Promenade are Litfield House (1830), Camp House, now Engineers' House (1831), and Trafalgar House (1830-35). By

Victorian times the enthusiasm for Bath stone facings was waning rapidly as was the popularity of the classical style. The Gothic revival brought with it new materials for domestic building, the rubble course work in Pennant and Triassic sandstone which prevails throughout Victorian Clifton.

Finally to the terraces; these were the great innovative buildings of the 18th century and, in tracing their development in Clifton, we see the same pattern as with the mansions, namely that early terraces were rendered, later ones often Bath stone faced. The earliest Clifton examples are to be seen in Chapel Row (now Nos. 262-266 Hotwells Road), built between 1720 and 1725; the houses are brick (No. 266 now rendered) with Bath stone confined to three string courses, quoins, window voussoirs and pedimented door canopies. In the adjacent Dowry Square, No. 9, the central house on the north side of the square, was probably the first to be built in 1725 with the ground floor in rusticated Bath stone, the upper floors rendered over brick, and with Bath stone used for quoins, courses, window voussoirs and door architrave. Nos. 6, 7 & 8 were built between 1725 and 1727 and are similar except that they lack the rusticated ground floor Bath stone. Nos. 10 and 11 were not built until 1745-46 and on these the use of Bath stone has slightly increased over the neighbouring house (No. 9) with its employment on all sides of the window architraves. Of the remaining houses in Dowry Square, those with Bath stone faces are either 19th century buildings (as the Clifton Dispensary, dated 1823) or have been refaced in the 19th century.

Clifton (and Bristol) were slow compared with Bath to build terraces on a large scale. After Dowry Square the next two terraces were in brick, Albemarle Row and Boyce's Building, both 1760s. There was then a break until the great building boom of the 1780s and early 1790s, cut short by the French Revolution and Britain's declaration of war on France in 1793; many of the terraces begun at this time were left unfinished as their builders went bankrupt and only towards the end of the Napoleonic wars did did building resume. The Bath stone-faced terraces in this group include Rodney Place, Harley Place, Gloucester Row, Saville Place and Windsor Terrace. Cornwallis Crescent was not completed until 1830. The early Victorian period saw the last of the terraces built; Clifton Vale (1843), Caledonia Place (1845), Vyvyan Terrace (1845), Worcester Terrace (1853) and Victoria Square (1855). All these terraces are faced in Bath stone and among them the Paragon (1809-13) is unique in being double fronted with Bath stone on both the concave and the convex fronts. Royal York Crescent, the longest of the terraces, is brick rendered with stucco.

Of all the public buildings in Clifton faced in Bath stone the most notable are the Assembly Rooms in the Mall (begun 1806) and the Victoria Rooms (1838-9). There is a small stretch of Bath stone rubble walling visible along the lower level of Wellington Terrace.

The only other Jurassic limestone used in Clifton is the famous Portland stone, but its use is very confined and can best be seen in the War Memorial of St. John's, Whiteladies Road. It is also the limestone used for dressings on the Council House, College Green (1952).

3. METAMORPHIC

The common roofing materials of Clifton buildings are either slates or pantiles. In the absence of medieval churches there is no lead roofing, though the turret on Tower House in Clifton Down has a lead capping. This lack of lead, other than in guttering, is perhaps surprising in view of the local lead mines. Lead was worked on the Downs during the seventeenth and eighteenth centuries, though the amounts were probably never large (Gough, 1930). Clifton College chapel has a copper hexagon tower (1909) and the Council Houses in Clifton Vale Close are copper roofed (1950s).

SLATE

The vast majority of slate roofs are dressed with Welsh slates. Nowadays many of these are being replaced by manufactured products made from pulverised slate, mainly because the art of cleaving slates is waning and real slates have become very expensive. The Welsh slates do not appear to have become popular in Clifton until the resumption of building after the Napoleonic wars. As the building boom set in during the 1780s the slate industry in north Wales expanded, exporting thousands of tons of slates by sea. With the turn of the century, canals were able to take the slate inland. Then in 1831 the tax on slate was removed and this greatly boosted their popularity and sales, especially in combination with the development of railways to transport the slates. With the housing developments in Clifton from the 1860s onwards, it is likely that the purplish-blue Welsh slate became a common roofing material. It was cheap and light-weight compared with pantiles and so could be used on more slender timber frames. An unusual use of slate is seen where Welsh slates in foursomes form chimney pots, a practice better known in Cumbria, but to be seen on Rodney Lodge in Clifton Down Road and a few other houses in the vicinity.

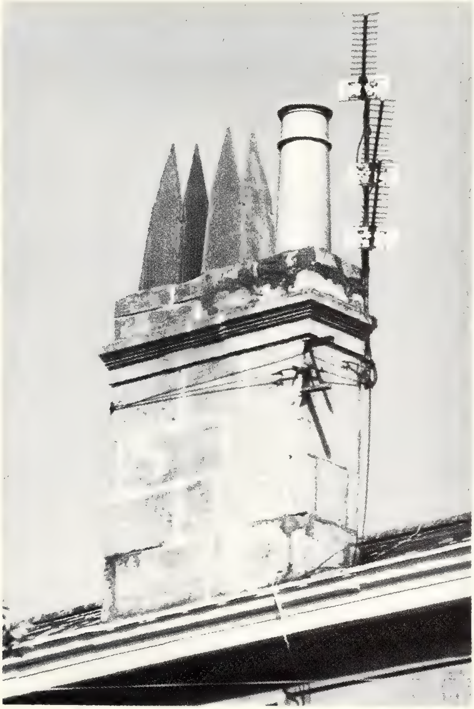

PLATE 6 Welsh Slate chimney pots on a house in Richmond Park Road.

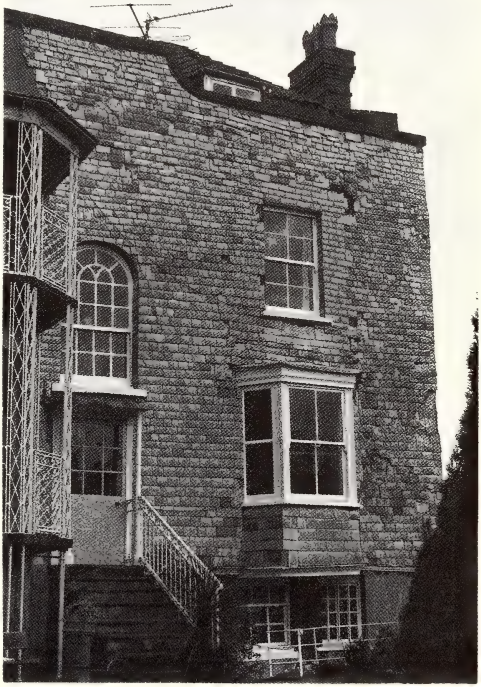

PLATE 7 Cornish slates hung on the walling of a house in Cliftonwood.

Some Clifton houses have Cornish slates, probably from the Delabole quarries in north Cornwall from where the slate could come easily by sea. These very distinctive and beautiful silvery slates may at one time have been a feature of Clifton mansions. They survive on one house in Dowry Square and as hung slate on the rear wall of a house in Clifton Wood Road and visible from St. Edward's Road. Slate hanging was popular in late Georgian and Regency times and can still be seen frequently in Cornwall.

A third type of slate is the green slate from Cumbria. Examples of this are rare in Clifton, but can be seen for example in the roofing of the Avon Gorge Hotel, Haberfield House, Cumberland Basin and the Parish Hall of St. John's, Whiteladies Road. Hope Chapel has recently been restored using Spanish slate.

MANUFACTURED MATERIALS

BRICKS

Although Bristol has had a major brickmaking industry throughout the past centuries, there are relatively few major usages in Clifton. The cores of many of the buildings are largely rubble stone, usually Pennant, Trias sandstone or Brandon Hill Grit. The occasional use of brick as a facing material in pre-19th century buildings is a rarity. Examples are seen in Dowry Square and Albemarle Row (1760s). Clifton Grove House (1730) and No. 262 Hotwells Road (1720s) have an interesting chequered pattern in red and cream bricks. The nearest brick works to Clifton was sited at Ashton Gate.

The imposition of a tax on bricks in 1784 may have influenced the increased use of Bath stone for ashlar facings. The tax was not lifted until 1850 and soon after that mechanised brick making began to take over from the hand-made brick. Also with these new processes, new clays were exploited; whereas previously most of the brickyards depended on alluvial clays, the new yards in the Bristol region utilised clays in the Triassic Marls and in the Carboniferous Coal Measures. The Cattybook brick pits near Almondsbury, north of Bristol, are sited in Carboniferous mudstones and reached their peak in the early part of the present century. Their screaming red waxy skinned bricks are all too familiar in Bristol and were conspicuously used for the Wills tobacco factory in East Street, Bedminster (1886) and for the three great tobacco bond warehouses in the Cumberland Basin (1905-19). Examples of the use of Cattybrook brickwork in Clifton can be seen on the Hotwells Public Baths, Jacob's Wells Road (1887, with terracotta dressings) and shops on Black Boy Hill, numbered 160-188 Whiteladies Road; some having Bath stone dressings, others terracotta. The finest of the latter row is the recently cleaned King's Arms Hotel.

PANTILES

Pantiles were first imported into Britain from the Netherlands in the late 17th century and by 1700 they were being manufactured here. Bridgwater, with its sea connections, became an important centre for their production, using local alluvial clays. Pantiles are, like bricks, made by firing and are not glazed. The Bridgwater pantiles were used widely in Somerset and in Bristol throughout the eighteenth and the first half of the nineteenth centuries, though subsequently Welsh slates began to replace them. There are still many buildings in Clifton with their attractive red Bridgwater pantiles and happily they have not totally vanished, though sadly nowadays a cement imitation, coloured red and often dusted with sand, frequently replaces the old hand-made pantiles.

ERRATUM - Plates 8 and 9 on Page 101 have inadvertently become transposed.

Bristol's Street Trees by A.L. Grenfell & A.C. Titchen will appear in a later volume.

The most remarkable roof in Clifton is that (recently renovated) on St. John's Parochial School (1850) at the top of Black Boy Hill. The tiles are coloured red, cream and black and arranged in a diaper pattern to give a very striking effect.

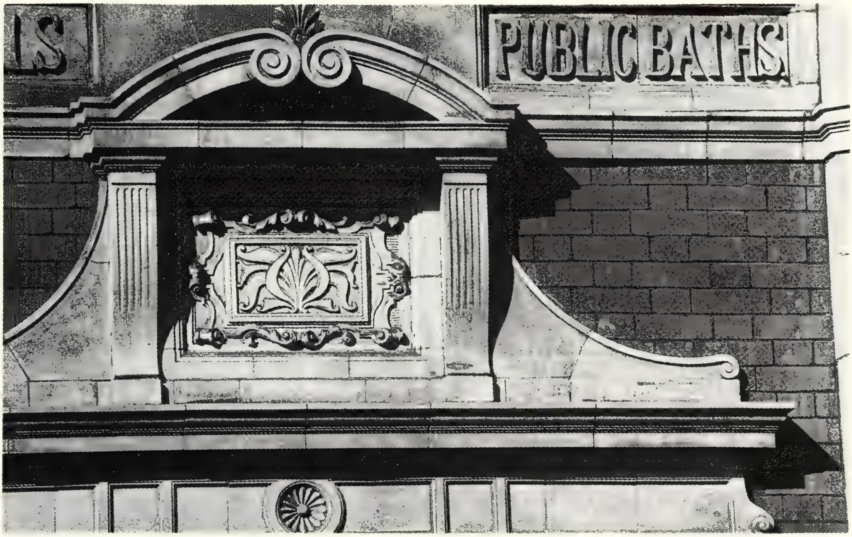

PLATE 8 St. John's School, Blackboy Hill, with diaper patterned roofing tiles in red, cream and black. The walling is a mixture of stones, mostly Dolomitic Conglomerate with white oolitic Carboniferous Limestone.

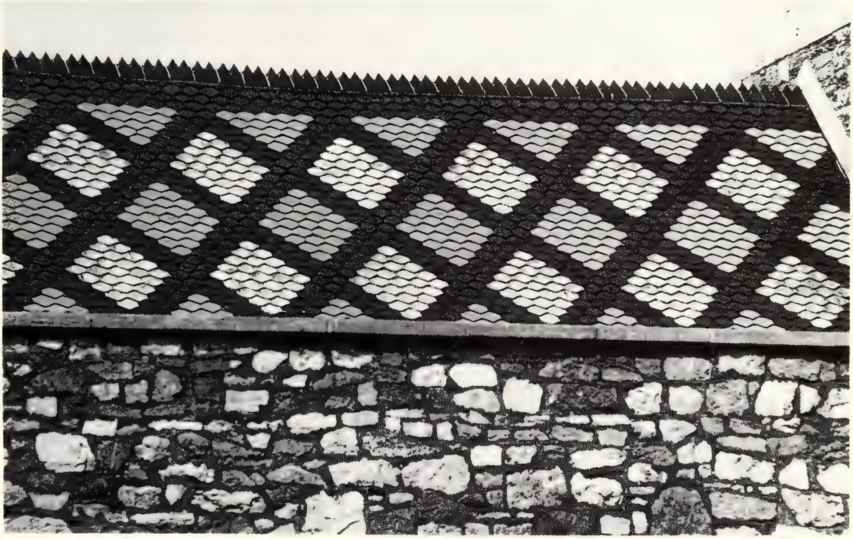

PLATE 9 Glazed Terracotta facing with Cattybrook bricks on the Hotwells Public Baths, Jacob's Wells Road.

GLAZED TERRACOTTA

This was a particularly widespread Victorian development, along with their mechanised bricks; terracotta has been used in Britain since Tudor times, but Victorian industry and ingenuity produced quite remarkable shapes and colours. Glazed slabs, larger than bricks, are used as facing material. Moulded into shapes with patterns in relief, they are often highly coloured and, above all, with their high silica content and high temperature firing, they are virtually indestructible. The Natural History Museum in South Kensington, London is a prime example of this craft. Clifton did not quite escape the rage, though it is not excessive. Examples of cream coloured terracotta imitating Bath stone and moulded with vermiform rustication can be seen in the quoin work of Victorian houses on the south side of Manilla Road. The cream coloured terracotta was often set in Cattybrook brickwork to produce a strong colour contrast and this can be seen with elaborately decorated terracotta in the architraves of the Hotwells Public Baths and shops at the top of Black Boy Hill (Nos. 182-188 Whiteladies Road).

Another Victorian use of terracotta was to make elaborately moulded yellow chimney pots, although happily these have not totally ousted the simple red conical pots of the Georgian era which are still to be seen in profusion.

FURNACE SLAG

In the early decades of the 18th century Bristol was the centre for the development of brass production in Britain. The smelting furnaces along the River Avon (sited there for water power) produced a lot of slag which had to be disposed of as waste. In 1749 the Bristol Brass Company was in trouble with the Bristol City Council for dumping slag on the banks of the River Avon; "a great quantity of Cinders laid upon the Banks of the said River by the Brass Wire Company, being a great nuisance and likely to choak up the said river if not

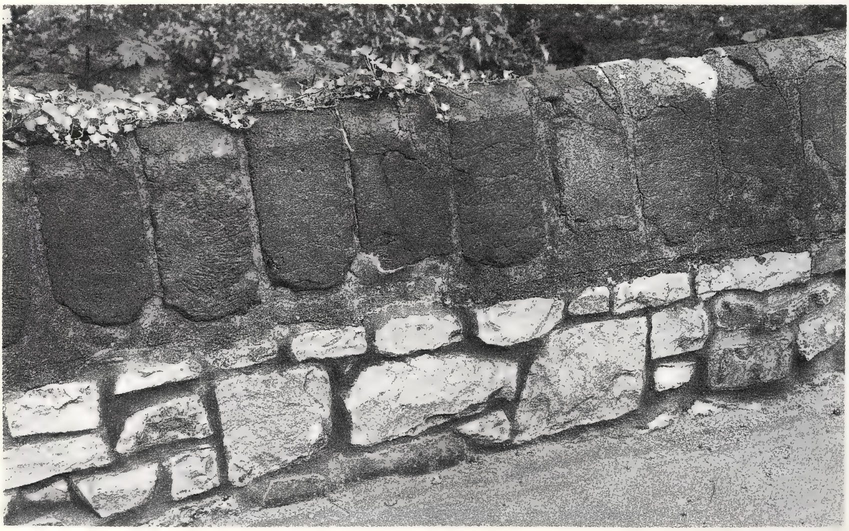

PLATE 10 Moulded slagstones used as capping stones on wall in Bridge Valley Road. Most of the wall in red (Triassic) stained Carboniferous Limestone.

removed" (Bristol City Archives Office, Minutes of Common Council, 18th August 1749, quoted in Day 1973, pp. 71-72). One solution was to resmelt the slag and mould it into blocks (usually 18½" x 9½" x 8") for use in walling; the resulting material is virtually indestructible. A good example of its use in walling is to be seen at the Chesterfield Hospital (formerly Clifton Court); here the south face of the building is in Bath stone, but the east wall is faced entirely in furnace slag blocks. The owner (and builder) of the house was William Champion, who was also director of the Warmley Brass Wire Company. The most celebrated use of this black volcanic-like slag is for the stable block at Arno's Court (1760s), a building dubbed by Walpole the Devil's Cathedral.

The slag was also moulded into triangular blocks which formed good capping slabs on garden and partition walling; the slag blocks are readily recognisable, for there are no examples of true volcanic lavas in Clifton walling. Examples may be seen along Lower Clifton Hill in the walling around Manor Hall and in the walling along Bridge Valley Road.

Another minor use of slag was in clinker form, used like pebble dashing to give a very coarse rendering, especially on basement and ground floor walls. It is usually seen today heavily painted, but the shape shows through. Examples can be seen in the lower walling of the Adam and Eve Inn on Hope Chapel Hill and on the end wall of Melrose Place, Whiteladies Road.

CONCLUSION

The paper gives some idea of the richness of the building materials in this single but exceptional parish of Clifton. We are indeed fortunate to have so many good local and regional stone varieties which architects and builders have been able to exploit to create the complex textures and colours that so enhance our buildings. This paper is but an introduction to an enormous and exciting area of historical research.

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